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JPMorgan

Industry Analysis

Data Networking and Telco Equipment

Back to Basics

- We are initiating coverage of the telecom and data networking sectors, with an Overweight rating on Cisco Systems; Neutral ratings on Tellabs, Nortel Networks, and Juniper Networks; and Underweight ratings on Lucent Technologies and Ciena.
- From a macro perspective, we are increasingly negative on the sector as a whole and do not expect to see many true value investment opportunities until demand at the end-user side of the food chain turns up again.
- We believe that in the near term, the sector is less about technology and more about nuts-and-bolts business and is even somewhat cyclical. We believe superior technology will lose to superior distribution, better supply chain management, and stronger balance sheets. In the longer term, we expect the traditional technology growth spurt dynamics of the industry to return, but not for about three or four years.
- We do not expect global carrier spending to bottom until early to mid 2004, with late 2004/early 2005 marking the beginning of the next upswing. Total North American capex alone should drop 12.5% in 2003 to $54 billion, although this is a marked improvement over 2002's 39% decline.
- Based on an analysis of standard economic indicators such as the ISM's Purchasing Managers' Index (PMI) survey, the Manufacturers' Shipments, Inventories and Orders (M3) durable goods data, employment data, and projections from JPMorgan economists, we expect enterprise spending to bottom in mid 2003 and begin growing again by late 2003/early 2004.

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Table 1: JPMorgan Data Networking & Telco Equipment Coverage

($ in millions, except per share data)

Company Name	Ticker	JPM Rating	Stock Price 11/25/02	Market Cap	Firm Value	Debt/ Assets	Firm Value to: Revenues 2002E	Firm Value to: Revenues 2003E	Firm Value to: EBITDA 2002E	Firm Value to: EBITDA 2003E	Net Cash / Share	Tangible BV/Share
Ciena Corp	CIEN	UW	$5.98	$2,577	$1,314[a]	27.3%[a]	3.9x	5.6x	NM	NM	$2.93[a]	$3.36
Cisco Systems	CSCO	OW	$14.89	$109,099	$87,911	0.0%	4.6x	4.6x	20.2x	14.5x	$2.89	$3.30
Juniper Networks	JNPR	N	$9.60	$3,551	$3,337	36.0%	6.2x	5.1x	104.8x	45.2x	$0.58	$1.74
Lucent Technologies	LU	UW	$1.84	$6,329	$9,145[b]	40.7%[b]	0.8x	1.0x	NM	NM	($0.82)[b]	($0.95)
Nortel Networks	NT	N	$1.85	$8,020	$8,009	27.3%	0.8x	1.0x	NM	61.1x	$0.00	$0.16
Tellabs Corp	TLAB	N	$9.48	$3,904	$2,897	0.0%	2.3x	2.5x	40.6x	48.3x	$2.44	$3.97

Source: Company reports and JPMorgan estimates. Ciena fiscal year ends October 31; Cisco fiscal year ends July 31; Lucent fiscal year ends September 30.
(a) Including debt, par value, not book value.
(b) Includes all convertible securities and $470M in off-balance sheet debt.

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INVESTMENT THESIS

We are initiating coverage of the telecom and data networking sectors, with an Overweight rating on Cisco Systems; Neutral ratings on Tellabs, Nortel Networks, and Juniper Networks; and Underweight ratings on Lucent Technologies and Ciena. Our primary thesis is that after four to five straight years of above-average spending levels and 30-40% growth in network equipment sales, the key North American and European economies that spawned the bubble years from 1997-2000 should have enough excess network equipment and capacity to last them through the next 12-18 months.

The enterprise sector, on which Cisco relies for over 80% of its sales, is more dependent on the state of the macro economy than on the dashed dreams of dozens of failed telecom startups and should therefore bounce back earlier as GDP and employment levels recover both domestically and worldwide, which we project for late 2003. Of the other five companies in our initial coverage universe, Juniper, Ciena, Lucent, and Tellabs get close to 100% of their revenues from telecom carriers, while Nortel gets approximately 75% from carriers, making it very important to get a solid handle on service provider dynamics.

Key Investment Points

Carrier Spending Remains Depressed into 2H04
Carrier spending should remain depressed into late 2004 or early 2005. Irrespective of any changes to the U.S. regulatory environment, we do not expect regional bell operating companies (RBOCs) and other incumbent U.S. provider capex to rebound for the next 18 months. Therefore, companies that are overly exposed to carrier customers, especially those in North America, should continue to have trouble holding the top line stable over the next six quarters. We currently expect total North American capex, both wireline and wireless, to decline 12.5% in 2003 to $54 billion, including a 13.7% decline in U.S. RBOC spending to $19 billion, a vast improvement over the 36% decline in 2002 RBOC spending. Spending growth in 2004 should be roughly flat.

Enterprise Spending Recovers Late 2003
Based on discussions with CIOs and an analysis of what we consider the key macro economic data, we believe that enterprise spending should remain relatively weak for the next eight to 12 months and begin to expand in the second half of 2003. We find that three macro-level economic indicators are helpful in identifying trends in enterprise and communications technology spending: the monthly ISM PMI data, the M3 survey, and the employment data from the Bureau of Labor Statistics (BLS). Using JPMorgan's official economic estimates of a 5.9% unemployment rate in 2003—up from 5.8% in 2002—and GDP increases of 3.5% in both first quarter and second quarter 2003 as guidelines for future economic activity, we estimate that enterprise spending will recover in late 2003. We further believe that a sustained increase in the GDP would decrease the unemployment rate, as the demand for new labor will begin to exceed the existing supply, thereby creating a ripe environment for enterprise IT spending going into 2004.

Best Technology Losing Ground to Basic Business
With most of the upstart telecom companies and their greenfield network deployments gone, we believe that the focus on revolutionary, ultra-high tech equipment will shift in favor of more evolutionary technology. While fancy new technology eventually drives progress, the large, incumbent customers buying equipment today have a difficult time integrating non-standard technologies into their legacy networks, and end-user demand for new technologies does not materialize overnight the way those in the industry once thought it did. In this environment, we place a larger premium on the nuts-and-bolts business disciplines such as supply chain and inventory management, the quality of the distribution channel, existing customer relationships, and, of course, net cash position.

Consolidation Seems Inevitable
It is our strong view that consolidation among the various equipment vendors is both inevitable and essential in order to preserve value in what should be a very profitable industry (as evidenced by the 40-60% gross margins). We note that the road to a consolidated industry will likely include a number of bankruptcy filings along the way. In our view, the two largest positives that could come about from such industry consolidation, whether via mergers or bankruptcies, would be:

1. A slower pace of competitive technology development leading to more contained R&D budgets and more rational technology development; and

2. The more benign pricing environment resulting from fewer players, as evidenced by the 60%-plus gross margins enjoyed by Cisco and Juniper in their two-player IP routing market versus the 30-40% gross margins reported in the more crowded telco equipment market.

Risks

Early Consolidation and Resurging Economy Revive Spending
Carrier spending is ultimately tied to carrier profitability, so anything that could accelerate the return of a more stable industry dynamic could revive spending earlier than we are anticipating and could provide a boost to our stocks. Aside from a macro rise in the overall global economy, consolidation in the carrier space would help rationalize industry structure and increase sector profitability and could lead to a renewed focus on capital spending.

An Unexpected "Killer App" Could Emerge
Network deployments are often preceded by the advent of a "killer application" that captures the hearts and wallets of end users and service providers alike. Napster almost was an enormous driver of new IP capacity but was nipped in the bud. The next killer app will most certainly be unforeseen but could exploit some underdeveloped part of the current network infrastructure and force an artificial demand bubble until that piece of network is properly deployed. When and how the next killer app emerges is, of course, always a mystery.

Summation and Valuation

There is no doubt in our mind that the telecom and data equipment vendors must consolidate, creating a stronger pricing environment with tighter cost controls and possibly a slower ramp of overall technology innovation. In the process, we expect R&D expense to fall from 20-25% of revenue today to the 10-15% range. The same thing needs to happen to SG&A, which also currently sits at approximately 25% of revenue industry-wide and should also fall closer to 15%. Getting to this consolidated world with fewer companies, less pricing pressure, longer product cycles, and lower operational expenses could take several years, especially because many smaller companies still have a lot of cash despite facing challenging business plans, low revenue prospects, and few customers.

Valuing the stocks in this sector is tricky business, if for no other reason than they are the quintessential growth momentum stocks. By definition, this means that when the top line grows, the stocks move up sharply, and when the top line shrinks, the stocks move down just as fast, irrespective of valuation. That said, the six stocks in our coverage universe trade at a range of price to book ratios of 1.1 (Ciena) to 3.8 (Cisco)—note that Lucent is off the bottom of the chart with its negative book value—firm value to revenue multiples of 1.0 (Nortel) to 5.6 (Ciena), and firm value to EBITDA multiples of 14.5 (Cisco) to 61 (Nortel). P/E ratios currently work only for Cisco, which trades at 27 times our calendar year 2003 EPS estimate of $0.55 (our fiscal year 2003 estimate is $0.53). Juniper is the next closest company to post positive earnings, and we project it to reach earnings breakeven only in 2003.

WHERE DID ALL THE DEMAND GO? LONG TIME PASSING . . .

We expect network operators in 2003 to continue ratcheting down spending levels to close to their so-called "maintenance level," forcing the equipment vendors in our space to keep expenses and breakeven points at equally very low levels as they wait for the next ramp in purchasing. We also see the global carrier market returning to a quasi-utility model, with long-term per annum growth rates in the 4-6% range and spending patterns growing closely in step with the top line. The resolution of various regulatory issues in the United States early next year could bring more stability to North American spending patterns but is not likely to provide the stimulus some people are looking for. Simply put, equipment spending recovers only when carrier top-line growth recovers, and that occurs only after end-user demand rebounds.

In our view, approximately seven to eight years of telecom spending, both by the primary carrier customers on equipment and by the vendors on R&D and manufacturing capacity, were essentially compressed into the four-year bubble period from 1997 to 2000. In order to handle the level of inordinate spending and the pace of development, equipment providers rapidly expanded manufacturing capacity and sales, marketing and overhead, and accelerated time-to-market for products that we believe in saner times would have come to market only four to six years later. Some of the fruits of this research, such as 32 wavelength OC-192 dense wave division multiplexing (DWDM), were category killers that disrupted the very business models funding the companies large enough to develop the technology in the first place. Other new technologies, such as the all-optical switch and even digital subscriber loop modems (DSL), to a degree, were simply rushed to market and introduced too soon and were neither mature enough nor economically viable enough to create sustained demand.

Where Did That Bubble Come From?

The bubble of the late 1990s stemmed from four very distinct sources:

1. The Telecom Act of 1996
2. The buildout of the Internet
3. The buildout of the digital wireless networks
4. The rebuild of the U.S. cable networks

It is our opinion that a confluence of events similar to these four, including the physical construction of three new communication networks, will not likely be seen again in this industry for a very long time. These growth factors repeating themselves in developing countries is highly unlikely.

The Telecom Act of 1996 created hundreds of new carriers—both local and long distance—and set off a technology arms race between the new entrants, who were blessed (or cursed) with a clean sheet of paper and large amounts of fresh investor money, and the incumbents who were cursed (or blessed) with even more money and legacy networks that needed upgrading. As these hundreds of new competitors executed on business plans that called for each to take five points of market share, demand for network equipment took on a life all its own, creating supply shortages and inventory corrections that rippled all the way down the foodchain.

The second driver was the growing popularity of the Internet, which led enterprises and consumers to buy new access, driving access line and voice grade equivalent (VGE) usage at a 40% CAGR for 1996-2001. The networks that sprang up over that period supported thousands of new ISPs and drove fresh demand for routers, switches, cross-connects, optical transport gear, and the like. In a sense, because the Internet is just the amalgamation of hundreds of thousands of local access networks woven together over surprisingly few large backbone trunks, the Internet network itself, from a physical perspective, was essentially built from 1997 to 2001.

At the same time, the third driver came from the wireless world, where, after unimpressive subscriber penetration of approximately 6.5% in 1993, user demand finally caught fire in 1994, bringing in approximately $91 billion of new capital over the eight-year period from 1994 to 2001. Net subscriber additions into the industry grew 18% per annum from 1993 through 2002, fueling the growth. Actual minutes of use surged 41% per annum from 27 billion in 1993 to an estimated 425 billion in 2002. Similar growth of wireless services in Europe and Asia helped drive international demand wireless for network infrastructure

The fourth and final driver of the bubble came from the major North American cable providers, which began aggressively upgrading their cable networks for two-way data and telephony readiness in a pre-emptive effort to own the broadband access market before the RBOCs could deploy and market their competing DSL product. For the three-year period from 1999 to 2001, cable company capital expenditures grew to 37% of revenue on an aggregate industry basis up sharply from just 20% in the prior three-year period. Actual capex dollars grew even faster, considering that cable company revenue was growing 10% per year over that timeframe.

Carrier Sector Still Healing

In the aftermath of the spending that occurred during the bubble period, the North American and European carriers are currently dealing with new sets of problems, having taken on too much debt in many notable instances while competing away what were once stable and dependable margins. Against this backdrop, the oft-dreamed of competition is finally beginning to materialize in North America as wireless phones, cable modems, and telephony and the unbundled network element platform (UNEP) system are increasingly substituting for RBOC access lines, eating away at incumbent market shares and revenue growth. Similar phenomena are occurring in Europe—especially in the United Kingdom and France—where newly deregulated local loops and aggressive cable companies are eroding incumbent market share as well. All of this is bad news for the equipment vendors in our universe, most of which are continuing to cut costs in order to keep pace with falling top lines.

The Way Out

So what should break the equipment vendors out of this state? Several things, including a more benign regulatory environment, consolidation among both carriers and equipment vendors, the advent of a new killer application that generates demand for new types of network equipment, and simply time, which should eventually work its healing magic through a newly resurging global economy, a lower jobless rate, and stronger end-user demand. Although it's hard to predict which of these happens first, we believe the gestation period for any of them is a minimum of 12-18 months, and therefore, we do not see any of these factors positively affecting our equipment company names through at least the end of 2003. We believe the survivors, and the stocks to own along the way toward a recovery two years from now, are the companies with strong balance sheets, deep and wide distribution channels, embedded bases of equipment, and strong incumbent customer relationships.

THEME NO. 1: CARRIER SPENDING RECOVERS IN 2H04

Unless the current downward trend in carrier revenues reverses itself soon, we do not expect capital spending at the RBOCs and at the other North American incumbent providers to rebound for the next 18 months. Therefore, companies that are overly exposed to carrier customers, such as Ciena, Tellabs, Juniper, Nortel, and Lucent, should continue to have trouble growing their own top lines over the next six quarters.

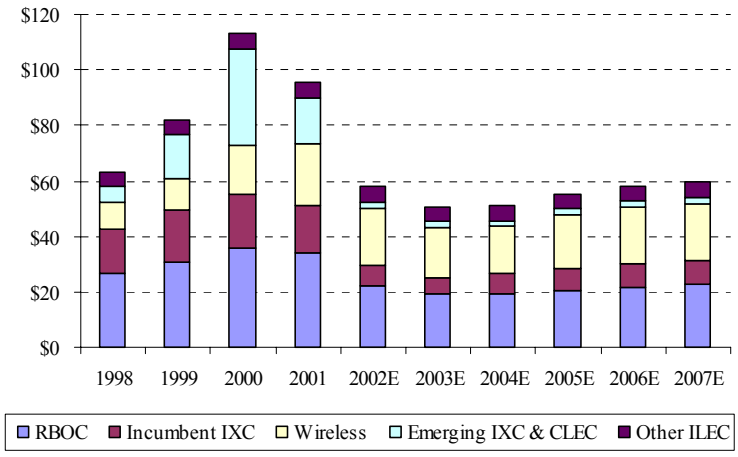
Our reasoning is based on two points. First, a rebound in enterprise spending generally leads the corresponding rebound in carrier spending by approximately six months, and we are currently estimating that enterprise spending does not begin to grow again until the end of 2003. Second, the major incumbent carriers, both domestically and overseas, are facing a laundry list of troubles in their core businesses above and beyond the lack of robustness in market demand. These troubles include exceptionally high debt (e.g., Qwest, WorldCom, Deutsche Telekom, France Telecom), new forms of competition (e.g., RBOCs entering the long-distance market and AT&T, WorldCom, and Sprint all entering the local market through UNE-P) and industry dynamics that have yet to rationalize (e.g., the entire U.S. wireless sector). We therefore expect these issues to take a good 18-24 months to get sorted out.

We currently expect total North American capex, both wireline and wireless, to decline 12.5% in 2003 to $54.1 billion, including a 13.7% decline in U.S. RBOC spending to $19.1 billion—vast improvements both over the 39% total and 36% RBOC spending declines witnessed in 2002. Our North American capex forecasts were made in consultation with JPMorgan telecommunications wireline services analyst Marc Crossman and wireless services analyst Thomas Lee. We believe spending across the board should be relatively stable in 2004 preceding the upturn in 2005.

Note that our 2003 spending estimate is only 7% below the actual run rate from the first nine months of this year, making the current quarter revenue totals at the wireline-intensive equipment vendors relatively good indicators of future performance.

Figure 1: North America Capex Forecast

($ in millions)



Source: Company reports and JPMorgan estimates.

Spending by the three major North American long-distance interexchange carriers (IXCs)—AT&T, WorldCom, and Sprint—should be $6.2 billion in 2003, down 19% from an estimated $7.7 billion in 2002 (based on WorldCom's recent monthly expenditures, WorldCom's capex should drop 60% in 2003), and then remain relatively flat in 2004 as all three look to conserve cash and raise the low utilization rates on the networks already deployed. We estimate that the emerging carriers and CLECs, which in 2000 comprised over 30% of wireline spending, will spend $2 billion in 2003, representing approximately 5% of the total wireline spending. We estimate that large ILECs, such as Bell Canada and ALLTEL, will spend $5.8 billion in 2003 down 3% from our 2002 estimate of $5.9 billion.

In wireless, we expect spending by the big six national providers to decline 12% in 2003 and another 6% in 2004 following a comparatively benign 6% drop in 2002 as CDMA providers Verizon and Sprint PCS roll off of their 1X-RTT upgrade buildouts and GSM/TDMA providers AT&T Wireless and Cingular (a joint venture between BellSouth and SBC) complete their overlay network builds.

Over the past 18 months, forward guidance for RBOC capex has come down over 10 times, largely in lockstep with RBOC top-line growth. At each guidance revision, the question that continually surfaces is how much lower can capex fall before the companies start to eat into their core business. This brings up the mythical concept of a maintenance level of spending, which we analyze from three different angles below. Note that our current capex estimates for 2003 do not assume that the RBOCs and other carriers fall back to their maintenance levels—in fact, our estimates of a 13.7% RBOC decline in 2003 and 12.5% decline overall for North America are more optimistic.

However, given the uncertainty surrounding the RBOCs' and other incumbents' revenue growth potential both this year and next, it is very helpful to understand how low incumbent spending could go if incumbents' top lines continued to erode and they brought down spending similarly.

Maintenance-Level Spending

A maintenance level of spending is the minimum capital investment required to support a carrier's current revenue stream and core business with no additional capital included to provide for future growth. Calculating the maintenance level of spending is not simple, and most carriers have only a rough idea of how low they can set their spending before they impair the network equipment that support their current revenue streams.

In part, this is due to the historical nature of service provider purchasing. Service providers, much like equipment providers, typically deployed capital in anticipation of demand for current services while simultaneously spending on network equipment in preparation of new revenue-generating services. Today, most carriers build network routes only as actual orders are placed, and capital deployment for new services is fading rapidly.

In addition, in North America, RBOCs previously were rewarded for deploying new network capital, because under the prevailing rate-of-return regulatory environment, they could generally pass on the costs to end users in the form of higher prices while growing net income. The question then becomes how low can carrier capex fall before it hits a maintenance level, and, by extension, when are we likely to see a bottom?

We attack the problem of calculating maintenance level of capex for the wireline sector using three different methods:

1. **Applying capex/sales ratios—**Setting the future capex to revenue ratio to levels used by the most capital efficient carriers under the assumption that if France Telecom and Deutsche Telekom can operate at capex to revenue ratios of 11-12%, for instance, then, at least in theory, so can Bell South, SBC, Verizon, and Qwest.

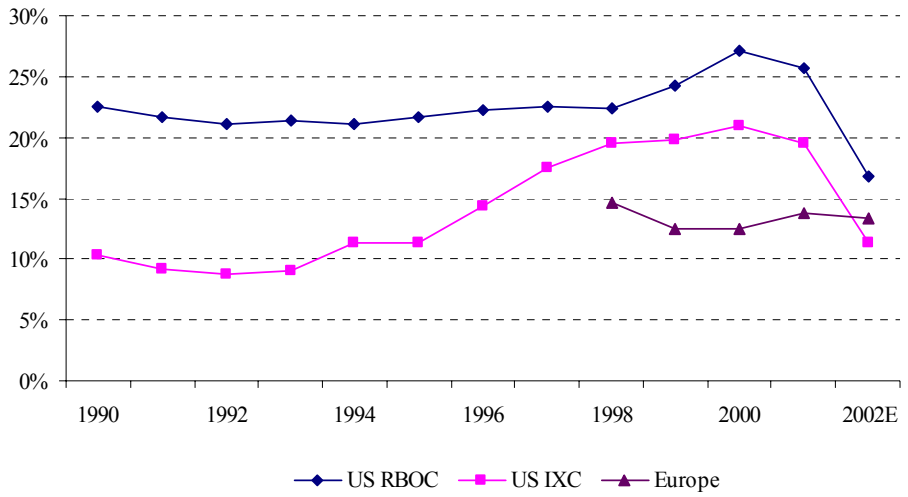
2. **Using absolute historical dollars—**Setting capex for each company to its historical level on an absolute-dollar basis, assuming that the vast improvements in capacity purchasing power per dollar today (through advancements in technology) outstrips both inflation as well as the larger revenue bases and more complex product sets carriers offer.

3. **Using capex to depreciation ratios—**Setting capex roughly equal to depreciation under the premise that historically, the RBOCs spent approximately $1.10 of capex for every $1.00 of depreciation. As expected, the capex to depreciation ratio steadily increased from this 1.1 times level over the period from 1990 to 1995 to a peak of 1.47 times in 2000.

Method No. 1: Capital Efficiency Ratios

From 1990 to 1995, the seven U.S. RBOCs operated at an average capital efficiency ratio of approximately 21.5%, while IXCs operated at approximately 10.0%. These numbers moved up sharply at the end of the decade, and by 2000, the RBOC and incumbent IXC ratios peaked at 27.1% and 20.9%, respectively, up 560 and 1,090 basis points from their historical averages. The peak spending patterns, which fell slightly in 2001 to 25.6% for the RBOCs and 19.6% for the IXCs, were driven by large investments in new fiber networks, as well as new network expansions, such as SBC's Project Pronto and Sprint's ION project.

Figure 2: Capex to Sales Ratios for U.S. and European Carriers



Source: Company reports and JPMorgan estimates.
Note: Selected European companies include British Telecom, Deustche Telekom, France Telecom, Swisscom, Telecom Italia, and Telenor.

Capex/sales ratios for selected European PTTs (Post, Telephone, and Telegraph administrations), however, have traditionally been much lower, averaging only 13.4% over the period 1998-2001 (data for the period 1990-1997 is difficult to get, as many PTTs were not public companies). Even today, some of the largest PTTs, such as France Telecom (FT) and Deutsche Telekom (DT), maintain a capex/sales ratio of approximately 11-12% for their domestic wireline business. We attribute the lower capital efficiencies of the European PTTs partly to the lower quality of network and voice services that the European networks provide (although it is far better today than it was even five years ago) and to the fact that they were essentially government agencies and therefore had large incentives to keep costs low.

Because the historically inferior network quality in Europe compared to the United States is not much of an issue anymore, we believe the 11-12% wireline capex/sales ratio exhibited by FT and DT—two of the largest European incumbent carriers—consistently over the past three years provides a good benchmark for setting maintenance levels for the U.S. wireline companies.

Table 2: Capex to Sales Ratios for Major U.S. and European Incumbents

($ in billions)

	2001			2002E		
	Capex	Revenue	Capex/Sales	Capex	Revenue	Capex/Sales
United States						
RBOC						
BellSouth	5.1	23.9	21.4%	3.8	22.7	16.5%
SBC	11.2	45.7	24.5%	7.5	43.5	17.3%
Qwest/U S West	5.7	13.4	42.5%	3.0	16.4	18.4%
Verizon	12.3	50.6	24.2%	7.8	48.8	16.0%
Total RBOC	**34.3**	**133.6**	**25.6%**	**22.1**	**131.4**	**16.8%**
IXC						
AT&T	5.8	42.2	13.8%	3.8	37.5	10.1%
Sprint	3.7	9.9	36.9%	0.9	9.0	10.1%
WorldCom	7.6	35.2	21.7%	4.2	32.6	13.0%
Total IXC	**17.1**	**87.3**	**19.6%**	**8.9**	**79.1**	**11.3%**
Total US	**51.3**	**220.9**	**23.2%**	**31.0**	**210.5**	**14.7%**
Europe						
British Telecom	5.2	26.7	19.6%	4.8	28.8	16.8%
Deutsche Telekom	3.8	34.8	10.8%	4.5	33.5	13.4%
France Telecom	2.7	23.2	11.7%	2.5	23.9	10.5%
Swisscom	0.5	4.4	12.3%	0.7	4.8	13.8%
Telecom Italia	2.2	15.5	14.0%	2.7	20.8	12.9%
Telenor	0.4	3.2	13.1%	0.3	4.0	7.3%
Total Europe	**14.9**	**107.8**	**13.8%**	**15.5**	**115.9**	**13.3%**

Source: 2001 actuals from company reports, 2002 RBOC and IXC estimates from JPMorgan U.S. wireline services equity research estimates, 2002 WorldCom estimates from FirstCall consensus, and 2002 European incumbent estimates from JPMorgan European telecoms incumbents equity research estimates.
Note: JPMorgan rates AT&T (T/$27.99), British Telecom (BTY/$33.13), and Swisscom (SCM/$28.70) Oveweight; Bellsouth (BLS/$28.36), SBC Communications (SBC/$28.40), Verizon (VZ/$41.00), Sprint (FON/$14.38), and Deutsche Telekom (DT/$12.01) Neutral; and France Telecom (FTE/$16.31), Telecom Italia (TI/$81.23), Telenor (TELN/$11.75), and Qwest (Q/$4.99) Underweight. All figures adjusted for calendar year ending December 31.

Going forward, therefore, we estimate that the RBOCs should be able to lower their capital spending to the historical DT and FT average of 11.5% and continue to maintain the current level of voice-only services. In fact, SBC's latest 30% capex haircut announced on September 26 sets its 2003 capital budget to $5-6 billion, which is 12-14% of JPMorgan's 2003 revenue estimate of $43 billion. Note that at this level of spending, the RBOCs would most likely not be able to spend much on new DSL initiatives or other broadband network deployments such as metro fiber rings. In addition, with capex set at 11.5% of revenues, as the RBOCs continue to win 271 long-distance approvals, they would likely not be able to market new all-distance services to large enterprises where new metro ring deployments are required. While spending this low could have a negative impact on medium-term RBOC revenue growth, it provides a baseline level that we believe represents a reasonable "bottom" in capex.

Table 3: Maintenance-Level Capex

($ in millions)

	2003E Maintenance Level					
	Maintenance Capex/Sales	2003E Revenue	2003E Capex	2002E-2003E Capex growth	JPM Capex	Delta b/w JPM & Street
US RBOC	11.5%	129,908	14,939	(32.3)%	19,058	(21.6)%
US IXC	10.0%	62,164	6,216	(19.3)%	6,247	(0.5)%
US Total	11.0%	192,073	21,156	(28.9)%	25,305	(16.4)%
Europe Total	11.5%	117,485	13,511	(13.3)%	14,659	(7.8)%
US & Europe	11.2%	309,558	34,667	(23.6)%	39,964	(13.3)%

Source: Company reports and JPMorgan estimates, except "Street" capex from FactSet.

Applying the 11.5% capex to sales ratio to the North American RBOCs and the 10.0% historical IXC average to the IXCs yields a $21.1 billion maintenance-level capex estimate

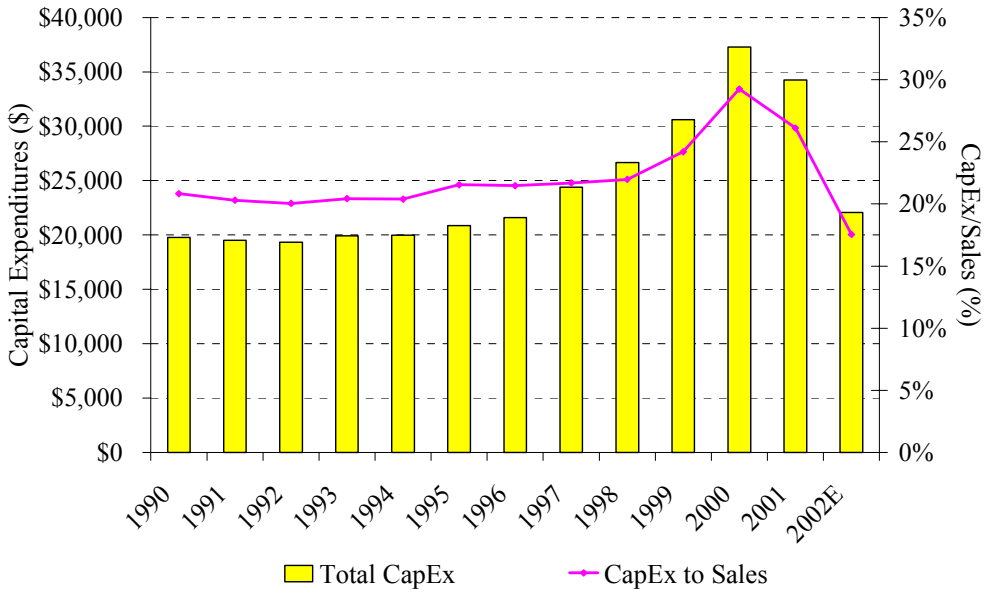
for 2003, down 30% from our 2002 estimate of $30 billion. Similarly, we estimate European maintenance level capex in 2003 of $13.5 billion for the six large European PTTs in our sample size (BT, FT, DT, Swisscom, Telecom Italia, and Telenor), down 12.6% from our 2002 estimate of $15.5 billion. Based on estimates and company guidance for revenues and capex in 2003, we believe that the incumbent carriers in the United States and Europe could still cut another 13.3% from current 2003 capex budgets—16% in the United States and 8% in Europe—before hitting bare minimum maintenance-spending levels.

Method No. 2: Using Absolute Historical Dollars

An alternative approach to using capital efficiency ratios is to project capital expenditures based on the absolute dollar level of spending before the bubble began. We use average capital expenditures from 1990 to 1995 as the benchmark of pre-bubble RBOC spending, as evidenced by the approximately flat annual average of $20 billion of capex from 1990 to 1995 (see Figure 3). The rationale behind this methodology is that improvements in capacity purchasing power per dollar today (from newer and denser technologies) allow the carriers to spend at the same historical level and still support a larger revenue base and service offering today that they did 10 years ago.

Figure 3: RBOC Capital Expenditure and Capex to Sales Ratios

($ in millions)



Source: Company reports and JPMorgan estimates.
Note: Carriers include BellSouth, Qwest/U S West, SBC, and Verizon.

Based on the theory that the average spending from 1990 to 1995 of $20 billion per year is sufficient even today to fully maintain the RBOC networks, we estimate that from 1996 to 2001, carriers bought more equipment than they needed in terms of optical transport and switching, cross connect capacity, data switches, and other next-generation equipment. In this scenario, we assume that the "normal" spending pattern of $20 billion per year only resumes after carriers burn through at least the reusable portion of the excess equipment they purchased from 1996 to 2001. We estimate this "excess" (defined as actual cumulative spending less implied normal spending) currently stands at approximately $21 billion.

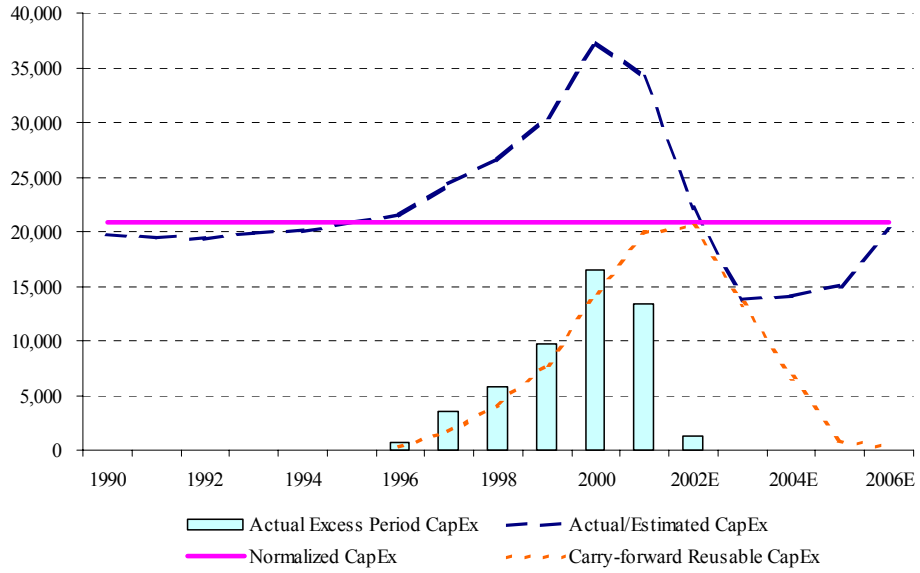
In our analysis, we assume that 40% of the excess inventory is actually reusable, meaning that of the $51 billion in cumulative overspending that occurred from 1996-2001, only $20 billion

of it represents actual and available spare equipment. Note that in addition to carriers' working through their own excess inventories, equipment purchased by now-bankrupt companies is still resurfacing in the market through gray-market sales, fire-sale auctions, and other venues, all of which creates a "lack of new need" for the carriers to spend additional capital on new equipment directly from vendors.

Figure 4 illustrates what carriers would have "normally" spent under this analysis compared with what they actually spent. The highest dotted line, which peaks in 2000, represents actual capex by the carriers. The solid line, at approximately $21 billion, represents our best estimate of the "normalized" capex that would have occurred in this analysis. The excess capital spent in each year is represented by the bars, and the lower dotted line shows the cumulative reusable excess inventory according to the 40% reuse estimate.

Figure 4: Excess Burn-Through in Maintenance Capex Analysis No. 2

($ in millions)



Source: Company reports and JPMorgan estimates.
Note: Carriers include BellSouth, Qwest/U S West, SBC, and Verizon.

In this method, we estimate that by the end of 2002, excess capex has stopped accumulating. In order to work off the $20 billion in excess reusable equipment within the next three years, therefore, RBOC capex must fall to approximately $14 billion in 2003 and 2004, rising slightly to $15 billion in 2005 before returning close to our "normal" maintenance spending level of $21 billion in 2006.

Table 4: RBOC Maintenance Capex Levels under Absolute Historical Method

($ in billions)

	2001	2002E	2003E	2004E	2005E	2006E
BellSouth	5.1	3.8	2.4	2.4	2.6	3.4
SBC	11.2	7.5	4.7	4.8	5.1	6.9
Verizon	12.3	7.8	4.9	5.0	5.3	7.1
Qwest/U S West	5.7	3.0	1.9	1.9	2.1	2.8
Total RBOC	34.3	22.1	13.9	14.1	15.1	20.2
% growth y/y	(4)%	(36)%	(37)%	2%	7%	33%

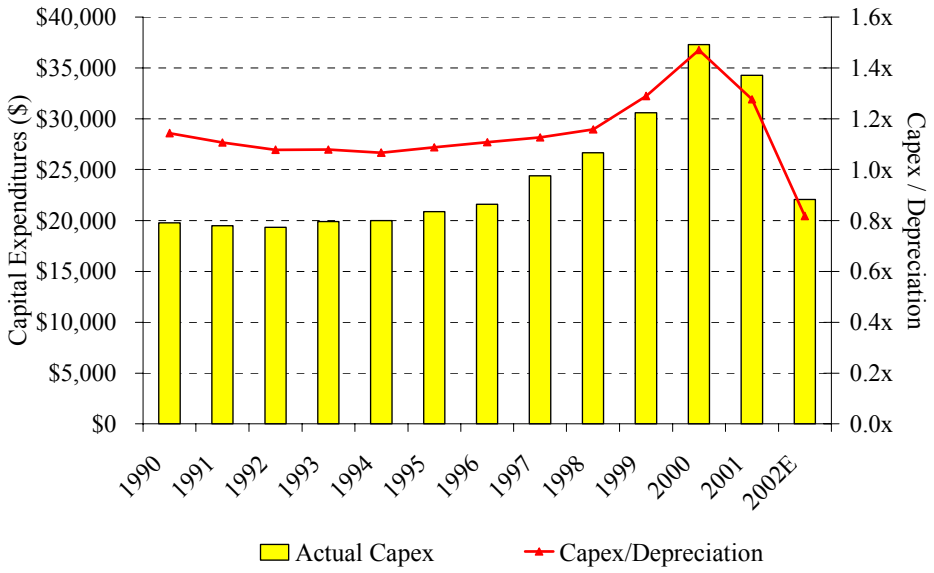
Source: Company reports and JPMorgan estimates.

Method No 3: Using Capex to Depreciation Ratios

Our third method of analysis is similar to the second one; however, instead of assuming that maintenance-level capex remains constant at the pre-bubble average of 1990-1995, we assume that capex in each year is equal to the depreciation in that year plus 10%. The 10% factor comes from the historical average capex to depreciation ratio of 1.1 times over the period 1990-1995, as shown in Figure 5. Figure 5 shows the capex to depreciation ratio for the RBOCs from 1990 to 2002E and illustrates that capex/depreciation was unusually high from 1996 to 2001, peaking at a ratio of 1.47 times in 2000. Note that between 1990 and 1995, both actual capex and the capex to depreciation ratio were relatively flat.

Figure 5: Aggregate RBOC Capital Expenditure and Capex to Depreciation

($ in millions)



Source: Company reports and JPMorgan estimates.
Note: Carriers include BellSouth, Qwest/U S West, SBC, and Verizon.

As in method No 2, we first calculate the amount of excess capital spent during the bubble period from 1996 to 2001 and then, using the same 40% reuse factor as before (i.e., 40% of the excess capital represents equipment that is still reusable in place of making new purchases), we set capex in 2002-2005 abnormally low to reflect the absorption of that excess capital. After that, we assume spending normalizes at 110% of depreciation.

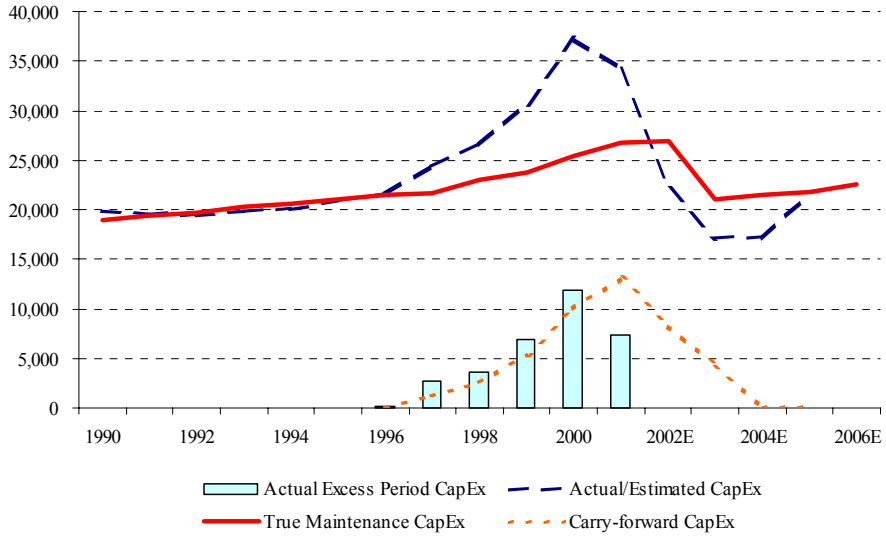
To calculate the excess capital spent from 1996 to 2001, we first derive a measure of what the "true" capex should have been in each of those years and then subtract it from the actual capex in that year—the difference being the excess—just as we do in method No. 2. For the "true" level of capex spent in each year from 1996 to 2001, we use the actual depreciation in that year, not 110% of it, as we do not want to bias the true capex measure by the excess spending itself. Under this method, the cumulative reusable excess equipment balance stands today at $8.1 billion, having already fallen $5 billion from the peak in 2001 of $13 billion owing to the 2002 capital spending cuts.

For the years from 2003 onward, we first set 2003 depreciation equal to the depreciation level of 1995—the year right before the bubble began—rather than equal to actual depreciation today, and then set the maintenance level capex back equal to 110% of depreciation in each

year. Depreciation naturally grows in each year by the 10% extra capital spent, and therefore capex grows with it. The reason we set 2003 depreciation to 1995 levels is that the actual current depreciation number includes all the depreciation from all the excess capital spent since 1996—capital that did not go into just maintaining the core business. Aggregate RBOC depreciation in 1995 was $19.2 billion, while estimated aggregate RBOC depreciation in 2002 is close to $27.0 billion. Figure 6 shows how our 2003 capex estimate (calculated as 110% of depreciation) is reset back to the 1995 level before growing again at normal rates.

Figure 6: Excess Burn-Through in Maintenance Capex Analysis No. 3

($ in millions)



Source: Company reports and JPMorgan estimates.

Figure 6 illustrates the difference between actual capex spent and our measure of "maintenance" capex from 1990 to 2006, as defined by 110% of depreciation. The highest dotted line, which peaks in 2000, represents actual capex spent by the carriers from 1990 to 2001 and estimated capex from 2002 to 2006. The solid line represents the "maintenance" capex. Note how closely the lines match from 1990 to 1996 before diverging during the bubble. The total excess capex in each year is represented by the bars at the bottom (the difference between the dashed and solid lines) and the dotted line at the bottom shows the cumulative reusable excess inventory according to the 40% reuse assumption.

Table 5: RBOC Capital Expenditure Forecast as a % of Depreciation

($ in billions)

	2001	2002E	2003E	2004E	2005E	2006E
Capital Expenditure						
BellSouth	5.1	3.8	2.8	2.8	3.6	3.7
SBC	11.2	7.5	5.2	5.2	6.7	6.9
Verizon	12.3	7.8	7.3	7.3	9.3	9.5
Qwest/U S West	5.7	3.0	1.8	1.8	2.3	2.4
Total RBOC	34.3	22.1	17.2	17.2	21.9	22.5
% growth y/y		(36)%	(22)%	0%	27%	3%

Source: Company reports and JPMorgan estimates.

What Figure 6 shows is that by setting capex flat at $17.2 billion in 2003 and 2004, we estimate that the RBOCs should be able to completely burn through the remaining $8.1 billion of excess capital and resume normal maintenance-level spending in 2005 (i.e., the dashed line in the figure comes back to meet the solid line in that year), a year earlier than the timeframe in method No 2.

Summary

Using the average of our three proprietary methods of analysis, the downside risk to our total 2003 RBOC spending estimate of $19.4 billion could be as much as 21% if RBOC top lines continue to erode and these four companies continue to cut their spending accordingly. Our actual $19.4 billion estimate for RBOC spending in 2003 represents a decline of 13.7% year over year, implying that our calculated maintenance level worst-case scenario would represent a decline of 30.6% from the 2002 level of $22 billion.

Table 6: Comparison of 2003 Maintenance Level Capex Across Our Three Methods

($ in millions)

	2003 Proprietary Maintenance Spending Calculations							
	#1 Capex/Rev	#2 Abs $	#3 Capex/Dep	Avg of 3 Methods	JPM '03* Forecast	Risk to '03 Fcast	JPM '02* Forecast	Potential y/y Decline
BellSouth	2,561	2,353	2,831	2,582	3,275	-21.2%	3,750	-31.1%
SBC	4,988	4,712	5,247	4,982	5,200	-4.2%	7,508	-33.6%
Verizon	5,549	4,895	7,285	5,910	7,705	-23.3%	7,800	-24.2%
Qwest	1,841	1,891	1,831	1,855	2,878	-35.6%	3,014	-38.5%
Total	**$14,939**	**$13,851**	**$17,195**	**$15,328**	**$19,058**	**--19.6%**	**$22,072**	**-30.6%**

Source: Company reports and JPMorgan calculations and estimates.
*JPM '03 and '02 capex forecasts are by U.S. wireline services analyst Marc Crossman.

Note that these calculations only apply to a bare-bones maintenance-level world, where no capex goes into developing new products or new sources of revenue. Once the current regulatory environment eases/stabilizes, and new sources of growth open up, we think wireline spending could accelerate again but not to the levels where it once was. However, given the relatively long lead times involved with preparing for new product and service introductions and the painful memory and long-lasting impact of the past spending cycle, we do not expect significant increases in carrier spending until 2004 or early 2005.

THEME NO. 2: ENTERPRISE SPENDING RECOVERS IN LATE 2003

Based on an analysis of what we consider the key macro economic data from the U.S. government and the Institute of Supply Manufacturers (ISM), we believe that enterprise spending should remain relatively weak for the next six to 10 months and begin to expand in the latter part of 2003, when the current economic recovery leads to a level of sustained growth that allows companies to increase their level of spending on networking equipment.

We find that three macro-level economic indicators are helpful in identifying trends in enterprise and communications technology spending: the ISM's monthly PMI survey, the M3, or durable goods survey, and the employment data from the Bureau of Labor Statistics (BLS). Traditionally, the business investment component of GDP has been the most widely used measure of business spending and is a good high-level proxy for addressable market growth for the companies in our universe (IT, which includes data networking along with many other non communications-related categories, represents over 40% of U.S. business capital investments today). However, we do not believe GDP adequately captures the full cause-and-effect mechanism operating in the economic environment (especially unemployment) and in spending by enterprises on networking and IT equipment.

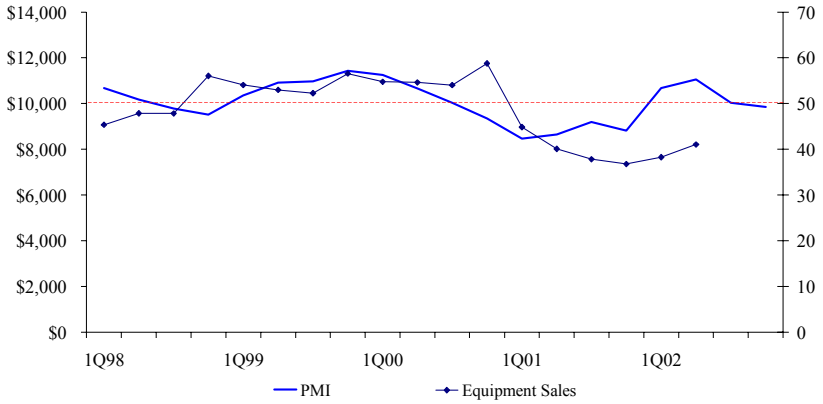
The advantage of looking at the PMI, as we discuss below, is that it includes a predictive element, while the M3 data give an industry-specific snapshot on the ordering and spending habits of equipment customers. We include an analysis of the unemployment rate to capture a measure of end-user demand for bandwidth capacity. Our theory is that an enterprise's demand for voice and data services, and thereby the network equipment needed to satisfy that demand, is directly proportional to the number of employees at that given enterprise. Therefore, we assume, more broadly, that overall demand in the industry is inversely proportional to the economy's unemployment rate. Overall, we believe our view on enterprise spending takes into account the economic indicators most relevant to our sector and looks at relationships with vendor data to estimate the direction of enterprise spending.

PMI Data

The monthly PMI data are very important and are widely viewed as a leading indicator of the manufacturing sector, as they provide a valuable first glimpse into economic activity. The PMI is a composite index of business forecasting that includes data on production, new orders, and employment. The PMI is reported at the beginning of each month and is scaled around a score of 50. Readings above 50 imply that the manufacturing sector is expanding, and readings below 50 imply that it is contracting. Historically, the PMI has been a useful leading indicator in predicting various economic cycles, and we believe it is also a useful indicator in estimating the direction of spending for both the overall communications equipment sector and the enterprise equipment subsector.

From Figure 7, which shows the relationship between enterprise equipment spending and the PMI from first quarter 1998 to second quarter 2002, we estimate that dips in the PMI, such as the one from first quarter 1998 to fourth quarter 1998, lead dips in enterprise spending by about three to four quarters. Similarly, the decline in the PMI from first quarter 2000 to first quarter 2001 led the first quarter 2001 falloff in spending by the same three- to four-quarter span.

Figure 7: Enterprise Equipment Sales vs. PMI Index, 1Q98- 3Q02
($ in millions)



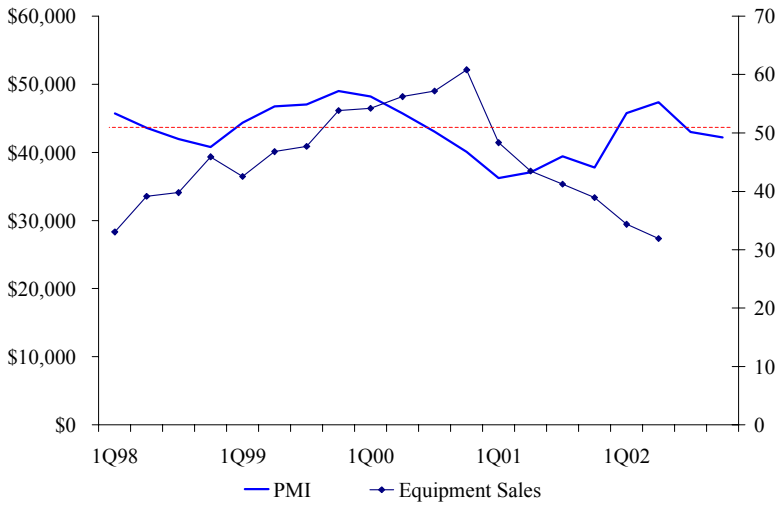
Source: Synergy, JPMorgan estimates and ISM

In first quarter 2001, the PMI began to increase and closed above 50 in first quarter 2002 for the first time in six quarters. Enterprise spending again lagged the indicator but picked up three quarters after the initial climb in PMI, growing sequentially in both first quarter 2002 and second quarter 2002.

Note that sustained index readings either above or below 50 also tend to provide more immediate one- to two-quarter indicators of a change in spending behavior, as happened in first quarter 1999, fourth quarter 2000, and potentially first quarter 2002. The difficulty is in knowing ahead of time if a given set of readings above or below 50 is the beginning of a sustained trend or not. Recent PMI data, for October 2002, for instance, was 48.5, suggesting a possible reversal in the recent upward trend for enterprise spending early next year.

Overall spending on communications equipment, which includes enterprise and carrier spending, appears to be equally well correlated with the PMI, as shown in Figure 8.

Figure 8: Total Communications Equipment Sales vs. PMI Index, 1Q98 to 3Q02
($ in millions)



Source: Synergy, ISM, and JPMorgan estimates.

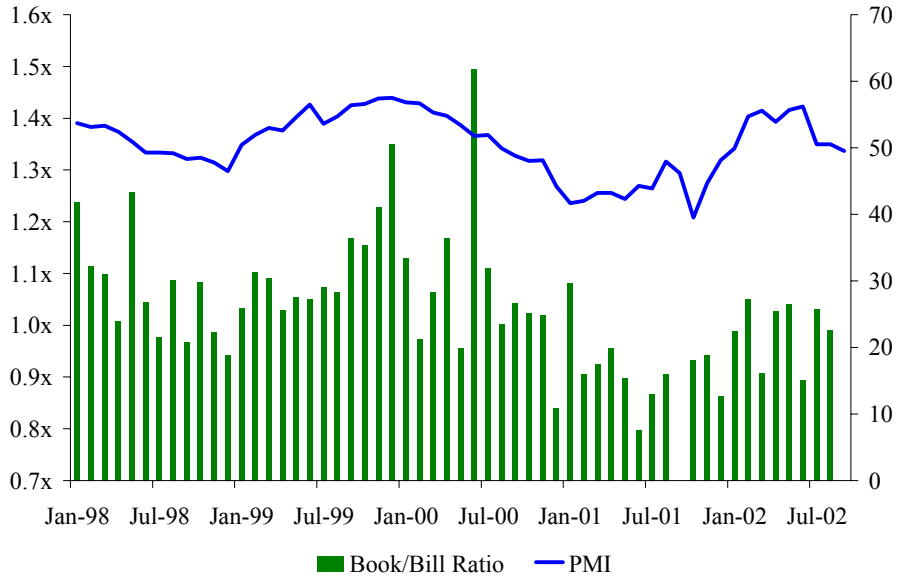
Again, there appears to be a roughly three- to four-quarter correlation between the leading PMI indicator and the lagging total communications equipment expenditures. The best example of this is the early 2000 dip in PMI that preceded the first quarter 2001 dip in total equipment spending by three to four quarters. While the uptick in first quarter 2002 PMI would appear to signal a fourth quarter rebound in spending, we anticipate that the continued excess of service provider equipment available in the system and channel, as well as the uncertainties surrounding the impending threat of war, could push out the spending rebound into mid to late 2003.

Durable Goods Data (M3 Survey Data)

Each month the U.S. Census Bureau releases durable goods data in its M3 survey. The M3 survey contains a report on durable goods that includes information related to manufacturers' shipments, new orders, backlog, and inventory. The data alone provide a "status report" for the industry but do not provide an indicator of future trends. For example, we believe that looking at a graph of equipment shipments for the past three years would not be useful in determining the direction of equipment spending. However, calculating a book-to-bill ratio from the M3 shipments and new orders data and plotting it against the PMI for the same time period yields a useful trend. Our analysis shows that there is a correlation between the M3 and PMI, and we believe this analysis can help provide a possible indicator of future spending on equipment.

In Figure 9, we plot the PMI against the book-to-bill ratio from January 1998 to the present. In periods in which the PMI declined, the book-to-bill ratio generally declined as well. Our analysis shows that in the 26 periods from January 1998 to July 2002 that the book-to-bill ratio and PMI were not moving in the same direction in the same month, the book-to-bill ratio followed the direction of the PMI within a one-month lag 70% of the time. (For example, if PMI moved negative in August and the book to bill was flat in August, the book to bill would be negative in September, with a 70% correlation). In addition, 73% of the time that the PMI was greater than 50, the book-to-bill ratio was greater than 1.0 times.

Figure 9: Book-to-Bill ratio vs. PMI Index, January 1998 to Present



Source: US Census Bureau and ISM.

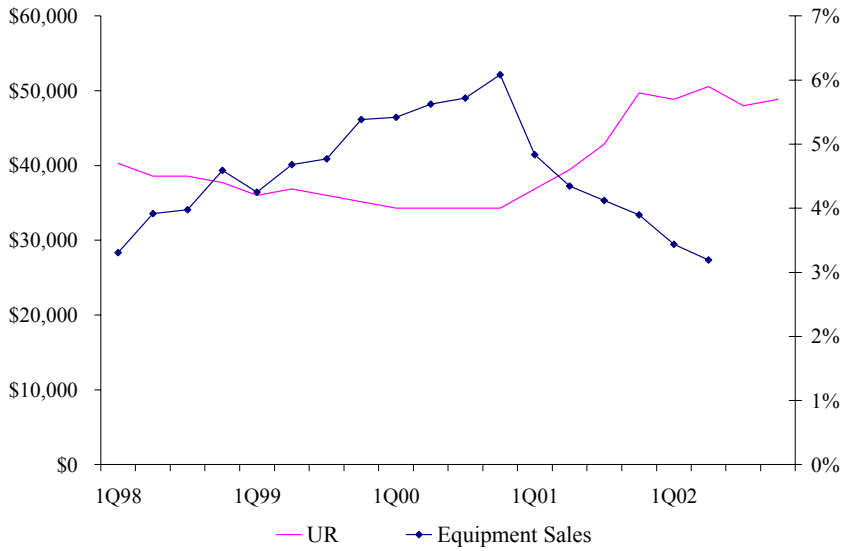
JPMorgan economists project 3.8% growth in first quarter 2003 in the business investment category of the GDP, up from a decline of 0.7% in the fourth quarter 2002 and up from a 2.7% decline in first quarter 2002. In addition, JPMorgan estimates that industrial production will be up 3.5% in first quarter 2003 from up a 1.0% decline in fourth quarter 2002. As the recovery continues, we estimate that business investment will continue to grow, with a larger share of the 2003 growth in the category going toward equipment instead of new plants and buildings. We believe that these factors could contribute to a positive trend in the PMI that should lead to an increase on spending for enterprise equipment.

Unemployment Data

We believe that the employment data provided by the BLS is another good indicator for the general direction of communications equipment spending. As employment grows, enterprises need additional communications equipment and networking bandwidth to support their expanding employee bases, and as employment declines, the need decreases. As seen in Figure 10, there appears to be a close indirect correlation between the unemployment rate and overall spending on communications equipment.

Figure 10: Total Communication Equipment Sales vs. Unemployment Rate, 1Q98-3Q02

($ in millions)

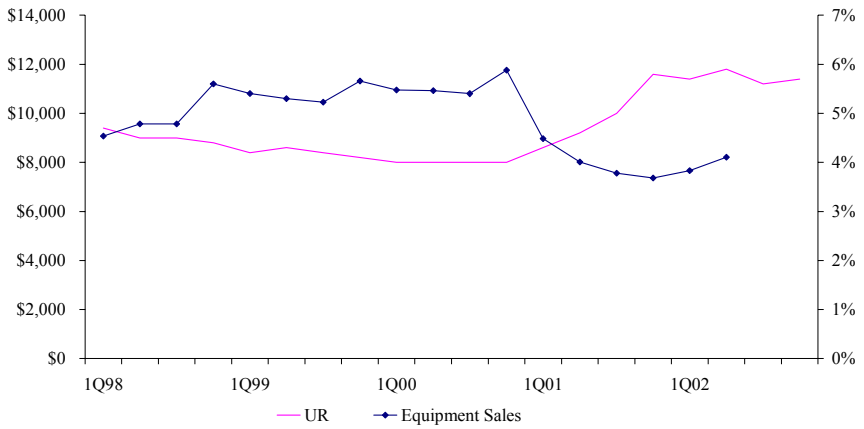


Source: Synergy, BLS, and JPMorgan estimates.

As the unemployment rate slowly declined from first quarter 1998 to fourth quarter 2000, spending on communications equipment steadily increased, and as the unemployment rate began to increase in early 2001, spending on communications equipment began to decrease.

Figure 11: Enterprise Equipment Sales vs. Unemployment Rate, 1Q98-3Q02

($ in millions)



Source: Synergy, BLS, and JPMorgan estimates.

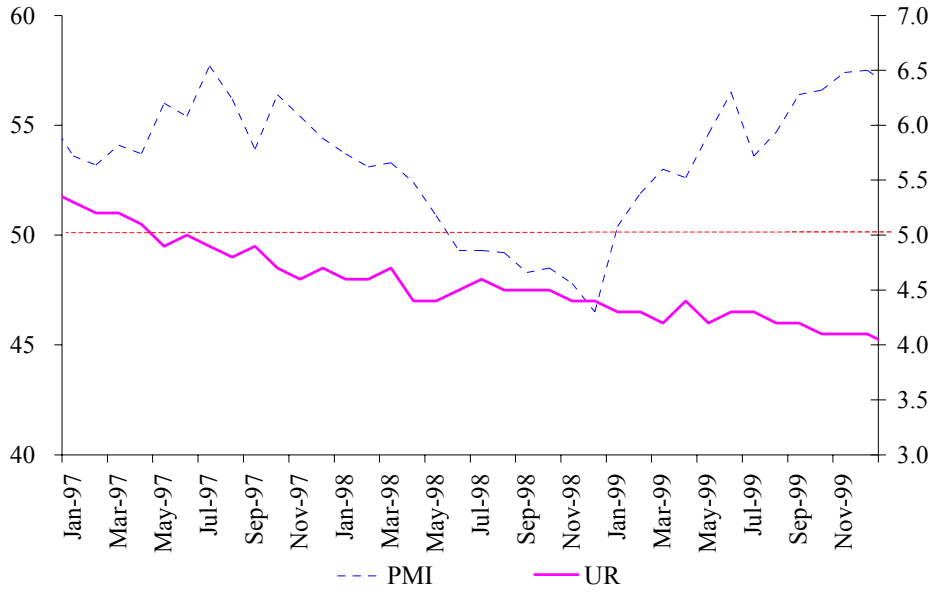
The same relationship holds true for enterprise spending. In Figure 11, we observe that when the increase in the unemployment rate began, in fourth quarter 2000, enterprise spending declined until fourth quarter 2001, as expected. The correlation is not 100%, however, as in second quarter 2002, enterprise spending began rising even as the unemployment rate rose, albeit at a much slower pace. In general, we believe that enterprise spending moves in the opposite direction of the unemployment rate. Therefore, when the unemployment rate decreases, over time, we should observe an increase in equipment spending.

Relationship Between PMI and the Unemployment Rate

While the PMI and unemployment are good economic indicators to use in our analysis, we note that in a situation where the PMI data are positive and the unemployment rate remains high (indicative of a "jobless recovery"), enterprise spending may lag the PMI until the unemployment rate begins to decrease. Figure 12 and Figure 13 illustrate our analysis, in which we compared the unemployment rate to the PMI from 1997 to the present.

Between 1997 and 1999, the PMI was generally above 50, except for a brief period in 1998, reflecting the Asian financial crisis and its related impact on the economic views of the manufacturers. During this period, the unemployment rate continued to decrease.

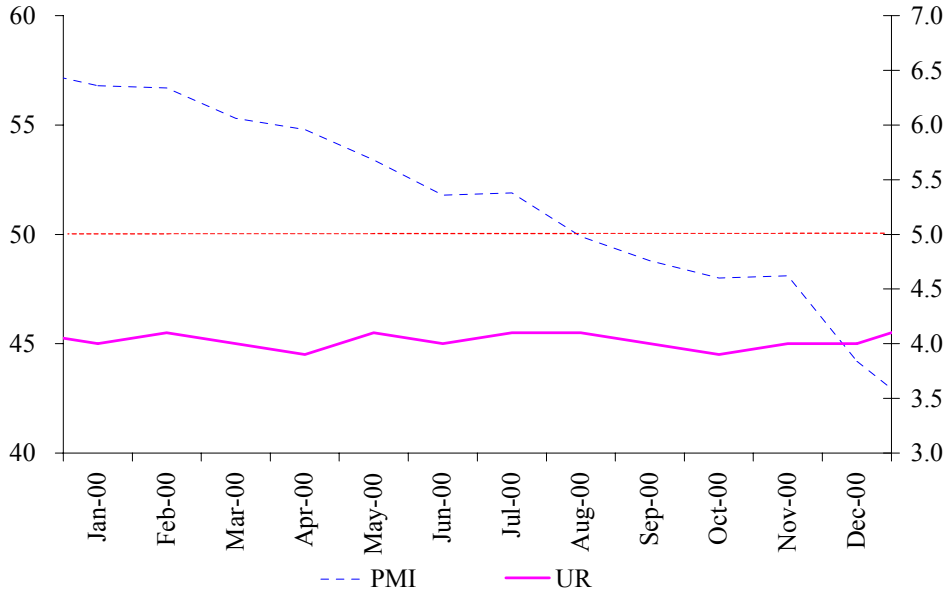
Figure 12: PMI Index vs. Unemployment Rate, 1997 to 1999



Source: Company reports and JPMorgan calculations.

In 2000, the PMI had a negative trend, going below 50 in August 2000, and unemployment remained flat, possibly illustrating that while the actual economic data were positive in 2000, the view throughout the year regarding future growth grew increasingly negative. Employers, however, did not shed jobs even as they reported an increasingly negative PMI.

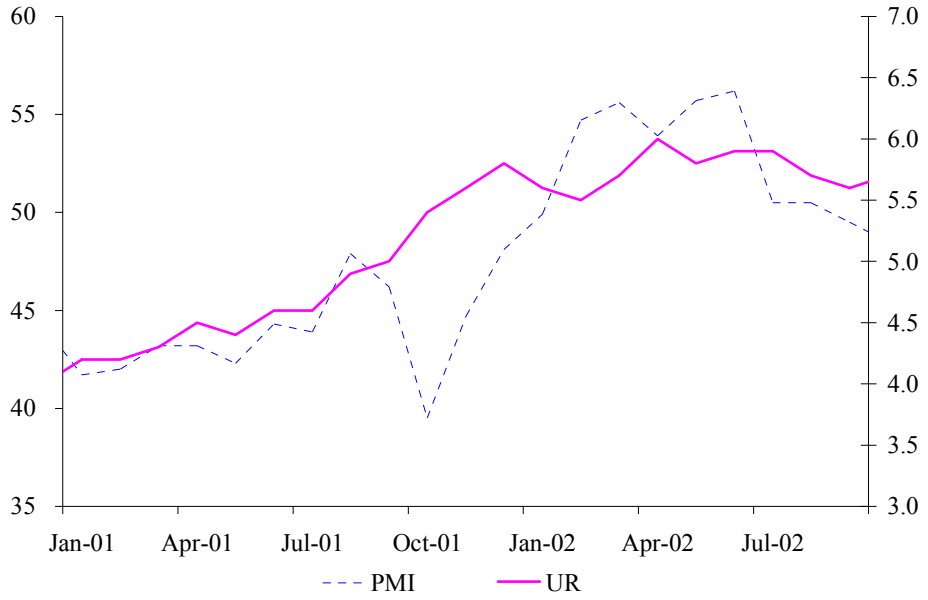
Figure 13: PMI Index vs. Unemployment Rate, 2000



Source: Company reports and JPMorgan calculations.

In Figure 14, which shows the relationship between PMI and the unemployment rate from 2001 to the present, the PMI data were relatively flat below 50 from January 2001 to August 2001, while the unemployment rate began to rise. The PMI, after September 11, 2001, took a steep decline but rebounded in November and continued to trend upward until February 2002. From February 2002 until June 2002, the PMI was relatively flat above 50, reflecting a net positive sentiment regarding the economy, and was reported at 50.5 in both July and August 2002. However, the unemployment rate has continuously increased from 4.2% in January 2001 to the current rate of 5.7%. As the PMI trended upward, we observed no measurable drop in the unemployment rate—i.e., companies did not add new employees even though they reported an increasingly positive PMI—but the upward slope in the unemployment rate did flatten out. In conclusion, we believe the best indicator of a muted recovery in equipment spending is the combination of a PMI above 50 and a declining unemployment rate.

Figure 14: PMI Index vs. Unemployment Rate, 2001 to Present



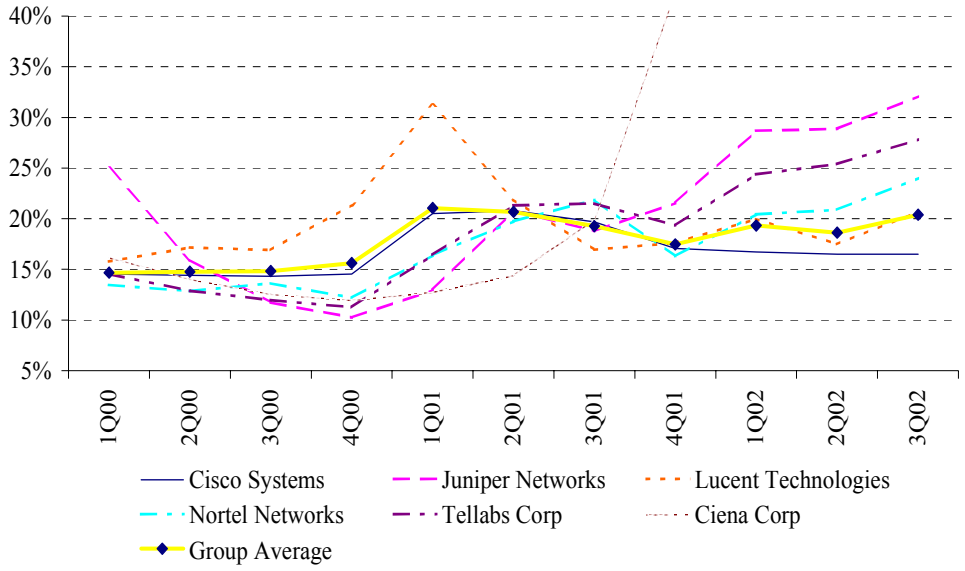
Source: BLS and ISM

Using JPMorgan's official economic estimates of a 5.9% unemployment rate in 2003, up from 5.8% in 2002, and GDP increases of 3.5% in both first quarter 2003 and second quarter 2003 as guidelines for future economic activity, we estimate that enterprise spending will recover in late 2003. These GDP projections include subcategory projections of business investment in equipment increases of 6.0% in first quarter 2003 and 8.0% in second quarter 2003, up from a 2.0% increase in fourth quarter 2002. We further believe that a sustained increase in the GDP would decrease the unemployment rate, as the demand for new labor will begin to exceed the existing supply, thereby creating a ripe environment for enterprise spending going into 2004.

THEME NO. 3: BASIC BUSINESS OVER TECHNOLOGY

From 1993 to 2000, the communications technology game was played best by companies that had the fastest and latest equipment. The combination of easy access to funding for startup product development and the rapidly expanding number of potential carrier customers that were trying to differentiate themselves through superior technology helped fuel innovation at dizzying speeds and sent aggregate industry R&D dollars soaring. Today, of course, most of those companies are either gone or going, and a fair number of the products they developed are gone along with them. What we are left with is an industry at a crossroads. In many ways the industry is still focused on future technology and is accustomed to using R&D dollars to get itself there, while in other ways managements know that they need to scale back operations in order to conserve cash for self-preservation.

Figure 15: Research & Development Expense as a % of Revenue



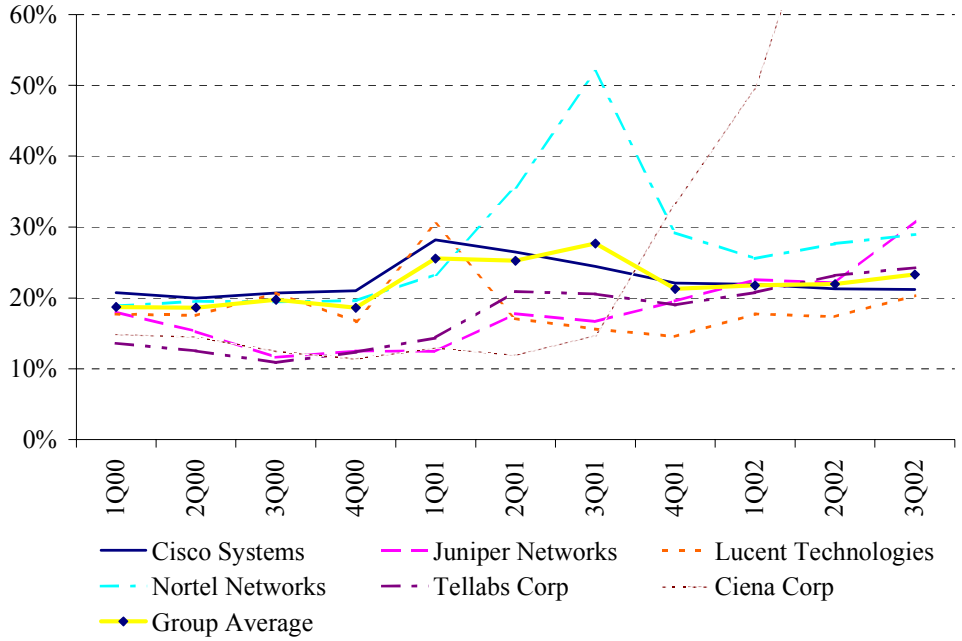
Source: Company reports and JPMorgan calculations.

Despite the fall in opex budgets around the industry, R&D expenses, as measured by the six companies in our coverage universe, have climbed steadily as a percentage of revenue, from a weighted average of 13% in first quarter 2000 to approximately 20% in the most recent quarter, although the majority of this increase is due to falling revenue totals. In this new game, we believe that companies that have better control over the operational fundamentals—i.e., good cash management, strong customer relationships, and control over both the supply and distribution sides of their business—have a competitive advantage over those who do not.

Cisco, with its huge embedded base of Catalyst switches and IP routers, its high-60s percentage gross margin, and its $3.6 billion annual R&D budget, is an example of a company that has managed to keep tight control on its business while maintaining one of the largest R&D budgets in the industry. However, we would suggest that Cisco, buffeted by $22 billion in cash, is something of anomaly and is not a model that would work for almost any other company in our industry. In fact, we would argue that Cisco's third-party distribution network of VARs, integrators, and resellers, and its tight management of its component suppliers (as evidenced by its industry-leading gross margins) are a more valuable asset than the company's extensive $3.6 billion annual R&D budget. At 16.5% of revenue, Cisco's

R&D budget is the lowest on a percentage basis for the six companies in our coverage universe.

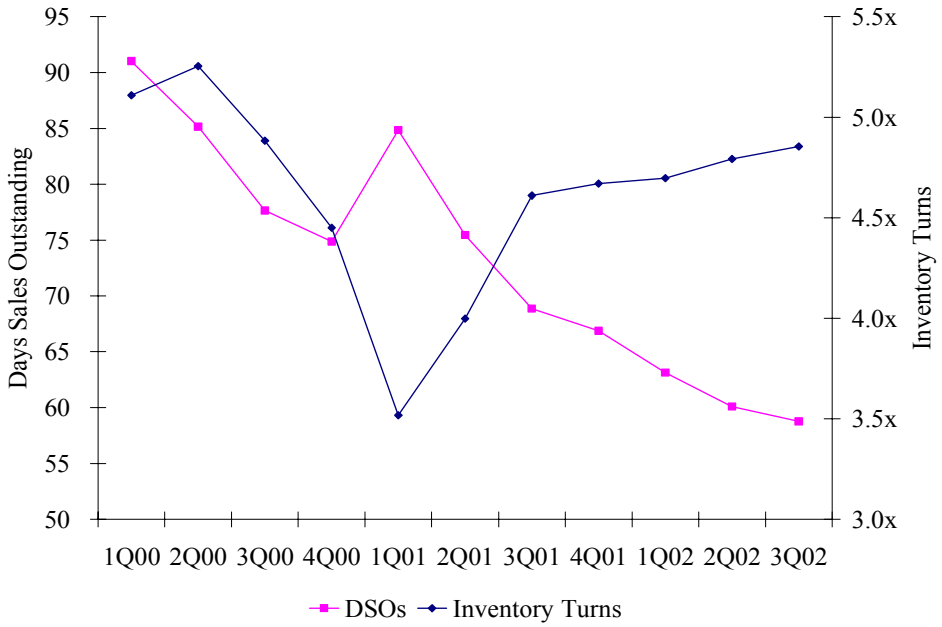
Figure 16: SG&A Expense as a % of Revenue



Source: Company reports and JPMorgan calculations.

Like R&D, SG&A as a percentage of sales has equally slowly crept up for the industry and now averages 26%, up from approximately 22% two years ago. Inventory turns for the industry average 4.9 times today only because of an anomalously high Cisco ratio of 7.5 times. Excluding Cisco, average inventory turns are 4.2 times, as $4.1 billion of inventory has been rendered obsolete over the past six quarters. DSOs for the six companies in our universe have actually come down over the past two years, from an average of 91 in first quarter 2002 to an average of approximately 60 in the most recent quarter as managements have pulled back on their looser credit terms and hoarded cash.

Figure 17: Days Sales Outstanding and Inventory Turns



Source: Company reports and JPMorgan calculations.

Tight control over cash burn is also an important differentiating factor among the companies in our universe, as the falling top lines have necessitated quick and deep cuts in spending. Of the companies in our initial coverage set, Lucent has the highest cash burn; we model the company burning through $2.3 billion of cash in 2003, $1.4 billion in 2004, and another $760 million in 2005 under the company's current restructuring plan. Next on our list is Ciena, which we expect to burn through approximately $60 million per quarter under its current restructuring plan. We expect Nortel's cash needs in 2003 to be $1.4 billion, falling to only $167 million in 2004, after which we expect the company to generate $150-300 million per year in cash from operations. Operations at Tellabs should bounce back from a $30 million cash use in 2003 to a $47 million cash source in 2004, as the company has restructured its headcount and expenses multiple times over the past 18 months to stay roughly in lockstep with its declining revenue. Both Juniper and Cisco, on the other hand, remain cash flow positive on an operating level.

RFPs Not What They Used to Be

Winning the request for proposal (RFP) game used to be a tech startup's ticket to authenticity—a validation of its technology and staying power that allowed it to raise fresh investor money and drive new innovation and more sales. In today's more frugal environment, however, large RFP contracts are seldom awarded to a new equipment provider with little operating history, making tracking the RFPs less relevant than it once was.

Additionally, we believe the sizes of announced contracts, if disclosed at all, will be lower than they were in the past, and RFPs, which used to be highly anticipated public events, will be much less relevant stock catalysts. We further believe this transition is in part already reflected in the market, as carriers have become increasingly reluctant to publicly commit to future spending plans, such as in a press release. Instead, we expect purchasing relationships to gradually build over time, rather than through upfront, agreed-upon dollar amounts at the onset of equipment shipments. While in the heyday of the capital spending boom it was not uncommon for the winner of a "bake-off" to be publicly anticipated and for the ultimate contract "winner" to be publicly announced and rewarded in the form of instant stock price appreciation, we do not expect to see much of this going forward.

CONSOLIDATION SEEMS INEVITABLE

Given the contracting nature of the telecom industry, we believe the sector needs to see a similarly contracting number of equipment vendors so that the surviving companies in the sector remain profitable. Given the sizable complexity and political difficulty involved in a large like-for-like corporate merger, we do not expect to see many whole-company mergers (i.e., Nortel for Alcatel, or Alcatel for Siemens' ICN division) among any of the 10-12 major global diversified equipment providers. Instead, we believe that mergers are more likely to occur along product division lines. Examples could be Lucent swapping its optical division to Nortel in exchange for Nortel's wireless business, or Motorola swapping its wireless infrastructure business to Siemens in exchange for Siemens' handset division, with an appropriate amount of consideration flowing in one of the two directions to equalize the value.

This consideration could easily take the form of equity, which would create a series of cross-ownerships in which each company would own stakes in the other company and its technologies, while each individual company would be more singularly focused on a particular business. The result of such corporate shuffling would be fewer companies in each individual marketplace, leading to greater pricing power vis-à-vis the consolidating carrier customer set and less duplicate aggregate effort on research and development.

Product Space Relatively Price Inelastic

One of the main advantages of a consolidated vendor universe is that with fewer companies selling the same types of equipment, vendors could begin to raise prices and expand margins. In contrast to voice long-distance service, demand elasticity, we believe, is not a major factor in telco equipment component purchasing, if for no other reason than unlike voice minutes in telecom, telecom equipment is not a perishable good. In fact, the ongoing cost of operation of the equipment is often more important to a would-be purchaser (carrier or enterprise) than the upfront cost of the equipment itself. For this reason, lower prices do not necessarily generate more demand for equipment (assuming that end-user demand is static).

Conversely, higher prices for equipment should not have the effect of choking off otherwise healthy volume growth either, but, in our view, getting to a higher price environment is contingent upon a consolidated industry with fewer competitors. We conclude that once the equipment industry begins to recognize that local, in-country, "most favored nation" relationships (i.e., Alcatel with France Telecom, or Marconi with British Telecom) are no longer immune to the impact of global competitors, and once the industry therefore begins to rationalize itself, we could see prices rise, and along with them, margins.

ADDRESSABLE MARKET OUTLOOK

The data networking and telecom equipment space has always been an alphabet soup of technologies, products, and protocols, and it's easy to get your VoIP confused with your GSR or your ATM. In this report, we are not going to spell out a compendium of definitions for all the acronyms, because frankly, we don't think it's all that important, as it bears little on stock movements. What we will do in this section is give a high-level framework or classification of the types of products encountered in this universe of companies and show which companies participate in which markets. We highlight six major market segments that make up the vast majority of revenue for our coverage universe. Other types of equipment, such as IP telephony, wireless LANs, and both narrowband and broadband access, are not described here owing to their small contribution of revenues to the companies in our coverage universe.

For each category, we give our own projections. While some of these are certainly inspired by third party industry consultant reports, the projections we give here are solely our own and are based on our own conversations with industry professionals, our own analysis and experience, and our own expectations of future market events.

The six major market segments we identify, in order from most attractive to least attractive, are:

1. Ethernet Switching
2. Wireless Infrastructure
3. ATM and Multiservice Switching
4. IP Routing
5. Optical Transport and Switching
6. Traditional Time Division (TDM) Voice

Ethernet Switching

Ethernet is the technology that powers the vast majority of all enterprise local area computer networks around the world. The products that make up the Ethernet market are generally viewed along three axes: technology layer, form factor, and speed. By technology layer, the market divides into three more segments: Layer 2, Layer 3, and Layer 4-7. The form factor subdivision only applies to the Layer 2 and 3 markets and consists of modular chassies, which are shelves or racks that carriers plug line-cards into in a modular fashion, and fixed units, which are thin, pizza-box sized boxes with a set number of ports. Finally, the speed categories are Ethernet (10 Mbps), Fast Ethernet (100 MBps or 10/100), Gigabit Ethernet (1,000 Mbps), and 10Gig Ethernet (10,000 Mbps).

Most fixed boxes have the capability of being "stacked" on top of each other and daisy-chained together to create a larger switch and are therefore also referred to as stackable switches. Because the number of ports supported by a modular unit expands as line-cards are added, they are generally used in higher traffic applications such as at the hub of a network, where multiple sub-networks come together. Fixed units, on the other hand, generally ship with 24 or 48 ports, are not expandable, and are used primarily in wiring closets covering either a floor or even a section of a floor in an office building. For purely marketing reasons, modular equipment is generally sold with more bells and whistles and fancier features such as remote network monitoring or auto-discovery than fixed equipment is, making modular boxes the higher end, more glamorous, and higher margin product of the two types.

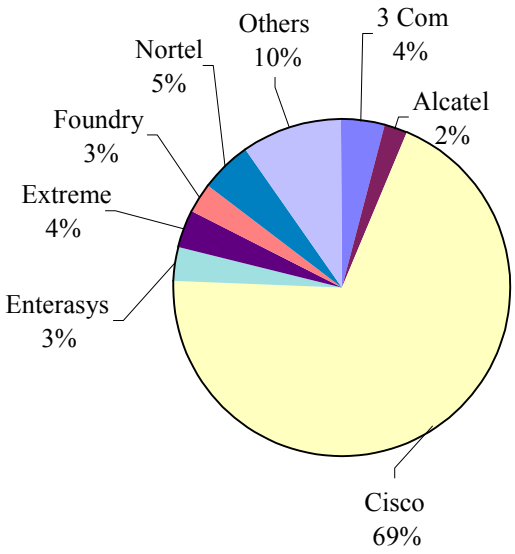
Table 7: Layer 2 and Layer 3 Switching Competitive Landscape

Vendor	Layer 2 Fixed	Layer 2 Modular	Layer 3 Fixed	Layer 3 Modular
Avaya	Cajun P1XX, P220, P330		Cajun P330	Cajun P88X, P5XX, P7XX
Cisco	Catalyst 29xx	Catalyst 4000/5000/6000	Catalyst 35XX	
Enterasys	SmartStack Vertical Horizons	Matrix E5/E6/E7		
Extreme	Summit 24e2/e3		Summit 24e/1/5/7/48i	Alpine 3800
Foundry	EdgeIron 4802F	BigIron	NetIron	
Nortel	BayStack 450	Passport 8100/8600	Passport 1100/1200	Passport 8600
3 Com	SuperStack II 6XX, 3XXX	Switch 4000	SuperStack III 4XXX	

Source: Company reports and JPMorgan.

The switched Ethernet market, which we expect to remain essentially flat in 2002 at $10.6 billion, down only one-half percent from 2001, is dominated by Cisco, which claimed a 69% share in third quarter 2002, up 200 bps from 67% from first quarter 2002 and up nearly 700 bps from its full-year 2001 share of 62%. The next largest players after Cisco are Nortel, with a 5% share; Extreme and 3Com, both with 4%; and Enterasys and Foundry, both with 3%. Lucent's Ethernet switch business is now in spin-off Avaya and held a 1.3% share in the latest quarter.

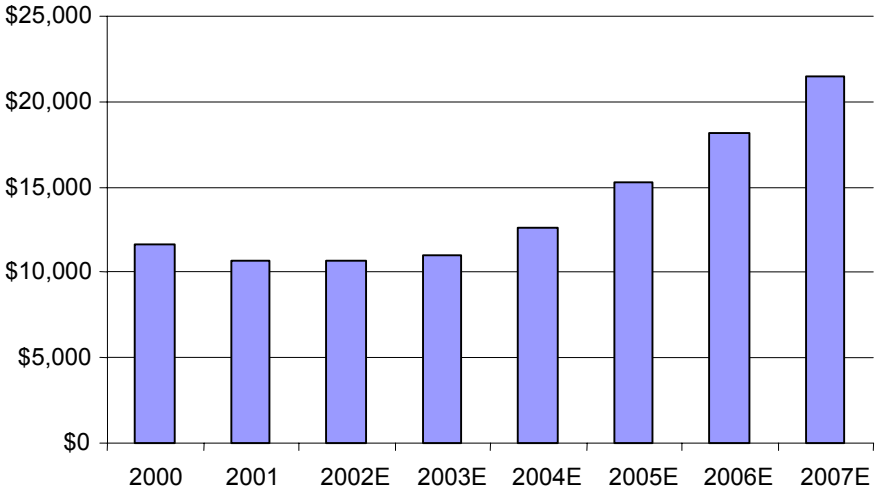
Figure 18: Ethernet Total Market Share—3Q02



Source: The Dell'Oro Group.

The Ethernet switch market, more that any other of our product categories, is driven by macro economic factors such as corporate spending and unemployment levels. We therefore expect it to remain relatively flat in 2003 and grow only 3.2% to $11 billion before reaccelerating to 15% and 21% growth in 2004 and 2005, respectively. Our optimistic 2004 and 2005 estimates are based on the expectation of an improving and growing global economy, a declining unemployment rate, and a trend toward more intelligent Layer 3 switches.

Figure 19: Total Ethernet Market Size, 1994-2007
($ in millions)



Source: Dell'Oro for historical figures, and JPMorgan estimates.

Layer 2 Ethernet

Cisco's dominance is most acute in the Layer 2 market, a subset of the larger Ethernet market representing 66% of the total, where the company holds a dominant 78% share. The next largest players in the Layer 2 market after Cisco are 3Com at 6% and Nortel at 3.7%.

Layer 2 fixed units are the most widely sold product and the most commodity-like of all the varieties, making this market more of a scale game than a high-tech features one. Prices per 100 Mbps port averaged $37 in the most recent quarter, versus $146 for Layer 2 modular ports, and have declined 15.2% over the past four quarters, versus an increase of 8.6% for modular port prices over the same period. We expect new entrants into this low-end fixed unit space—specifically Dell and Asian vendors Huawei and ZTE—to push pricing down further, as product differentiation is difficult.

Figure 20: Layer 2 Fixed 100 Mbps Ethernet Switch Volume vs Price

(volume, 000s)

Source: The Dell'Oro Group.

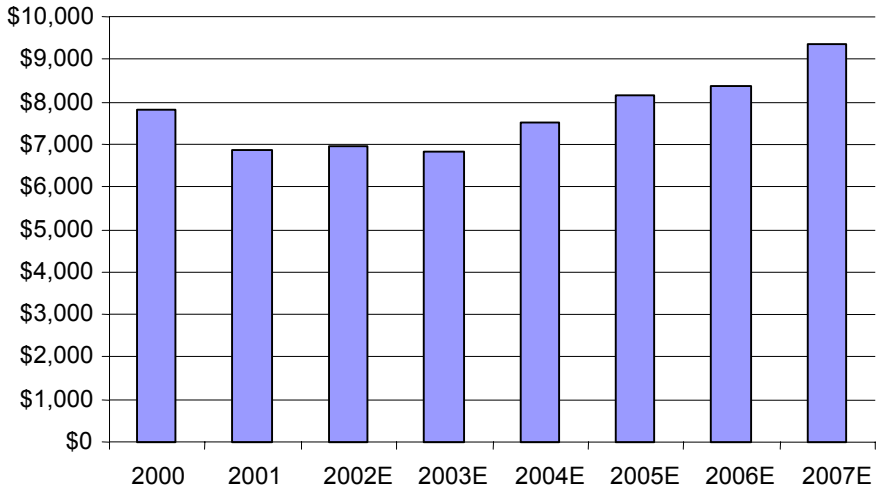
Over the past four years, port growth in both Layer 2 categories—fixed and modular—has primarily been driven by the upgrade cycle from 10 Mbps to 100 Mpbs, a cycle that we believe is largely complete at this point, given that 10 Mbps port revenue dropped below 2% of total Layer 2 in the first quarter of 2001 While there are compelling reasons to believe that the next upgrade cycle from 100 Mbps to 1000 Mbps (GigE) should be underway in the not-so- distant future, low utilization rates in most corporate LANs and the current price differential between 100 Mbps and GigE speeds ($42 per port versus $255 per port for the same Layer 2 fixed variety described above) suggest to us that a sharp ramp of GigE ports at the expense of 100 Mbps is still at least four to six quarters away.

In the meantime, we expect the weak economy to push total Layer 2 port shipments (both fixed and modular) down into the 17-19 million per quarter range throughout 2003, down approximately 10-15% from last quarter's 20.4 million total and equivalent to the level since second half 2000. This should keep the total Layer 2 Ethernet market roughly flat at $6.8-6.9 billion from 2001 to 2003. By early 2004, however, we expect a rebounding

economy and renewed corporate IT spending to boost port volumes into the 22-23 million per quarter range, pushing the total Layer 2 market up 10% to $7.5 billion .

Figure 21: Total Layer 2 Ethernet Market Size

($ in millions)

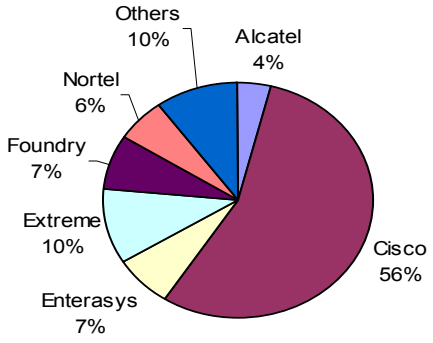


Source: Dell'Oro for historicals, and JPMorgan estimates.

Layer 3 Ethernet

The Layer 3 market is somewhat more competitive than the Layer 2 market in that Cisco holds only a 55% share, up from 40% a year ago. The next largest players are Extreme, with 10%, Foundry with 7%, and Nortel with 6%. The rapid proliferation of Layer 3 switches over the past three years was largely due to the adoption of this new technology into an installed base that was largely populated with Layer 2 switches. New applications enabled by Layer 3 switching, such as packetized voice, streaming media, and security, are pushing demand for these switches, although demand for Layer 3 switches has tapered off over the past five to six quarters with the downturn in the economy.

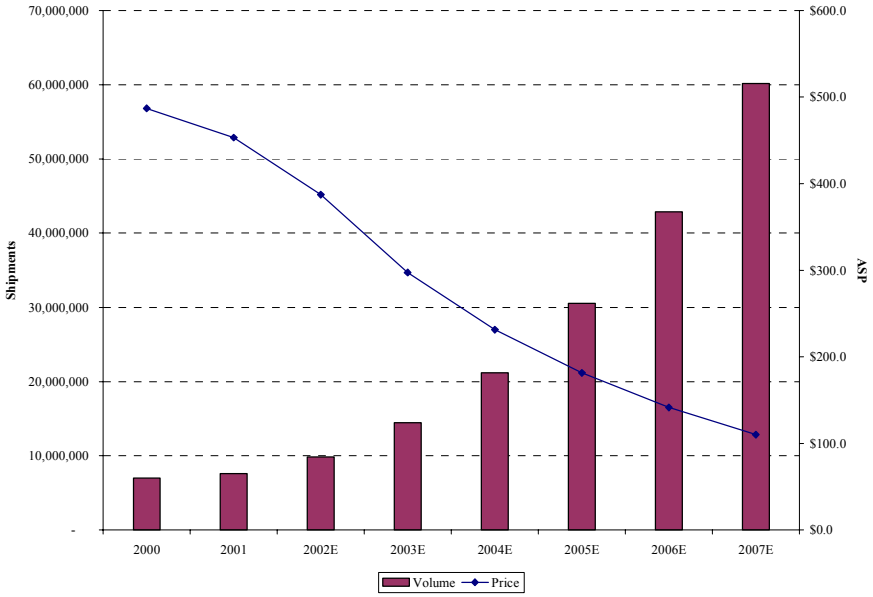
Figure 22: Layer 3 Ethernet Switching Total Market Share—3Q02



Source: The Dell'Oro Group.

Despite a brief renewal of growth over the past two to three quarters, driven by the early 2002 introduction of Cisco's new line of fixed switches (including the 3550), we believe sustainable growth in Layer 3 ports should return only with a rebound in enterprise spending, which we anticipate could happen in second half 2003.

Figure 23: Layer 3 Total Ethernet Switch Volume vs. Price (2000-2007E)

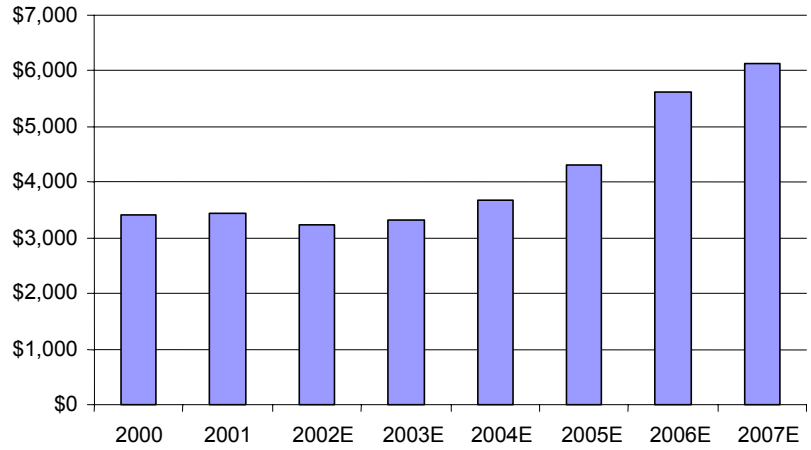


Source: Dell'Oro for historicals, and JPMorgan estimates.
Note: 2002-2007 are estimates.

While average per-port pricing for Layer 3 switches remains relatively high at $260, as of third quarter 2002 (versus $82 for the average Layer 2 port), it is still down 44% from $464 in the year-ago quarter, driven in part by lower component costs as Cisco and others have started using lower cost merchant silicon to drive down costs and thereby pricing. We estimate prices for Layer 3 ports will continue to fall approximately 10% per year, resulting in a sub-$300 average port cost by mid 2004.

Figure 24: Total Layer 3 Market Size

($ in millions)

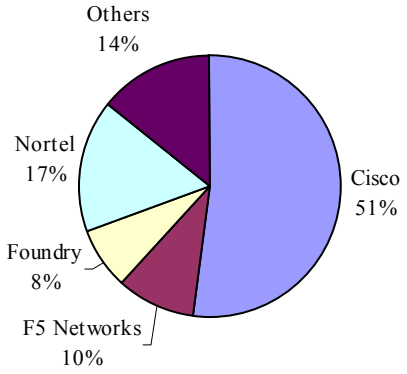


Source: Dell'Oro for historicals, and JPMorgan estimates.

Layer 4-7 Ethernet

The Layer 4-7 market is the most competitive of all three markets, if for no other reason than the fact that it's the newest and by far the smallest. Cisco's leading share in this market was 51% as of third quarter 2002, followed relatively closely by Nortel at 17%, F5 at 10%, and Foundry at 8%. Layer 4-7 switches are more often than not implemented in software and run on standard servers from HP, IBM, Sun, or Dell, although specialized hardware versions, called "appliances," exist as well.

Figure 25: 3Q02 Layer 4-7 Market Share



Source: The Dell'Oro Group.

Layer 4-7 switching is also referred to as "content-aware" switching because packets are switched through the network based on a relatively thorough examination of nearly all of the content inside the packet, as opposed to just the destination address, as in Layers 2 and 3. The primary applications to date have been load balancing, fault tolerance, and security in both Internet and intranet web environments. A simple example is the data/packet -switched analogue to the well-known voice/circuit -switched application that routes 800 toll-free calls from anywhere in the country to the nearest call center, or to a call center that has available reps, etc. In the data packet world, this could be a system that routes orders on a retail website (such as J. Crew, Banana Republic, etc.) to one of multiple different servers around the world based on location, type of transaction, etc.

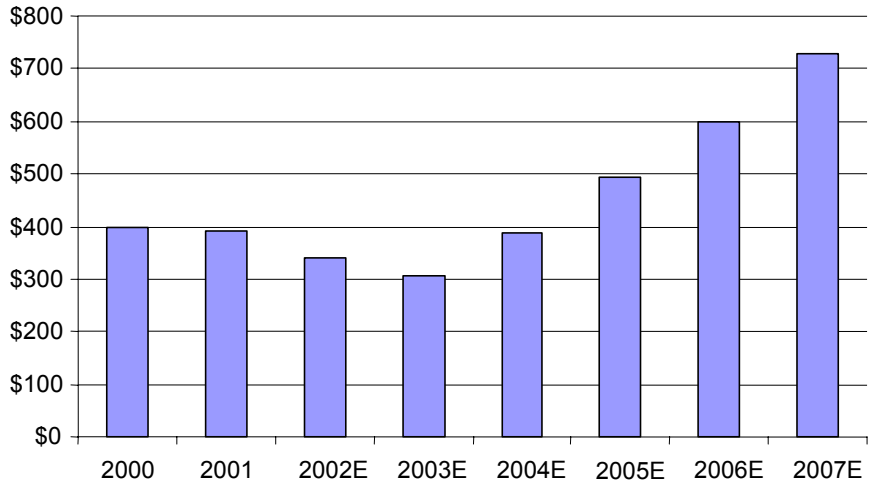
Table 8: Layer 4-7 Switching Competitive Product Landscape

Vendor	Layer 4-7 Fixed	Layer 4-7 Modular	Layer 4-7 Appliance
Cisco		CSS-11XXX	LocalDirector Distributed Director
Nortel	Alteon Ace Director		
F5 Networks	Big IP 2000/5000		Big IP 500 3DNS
Foundry	TurboIron ServerIron		
Extreme			Summit Px1

Source: Company reports and JPMorgan.

While the applications made possible by Layer 4-7 switches are very cutting-edge, interesting, and "just plain cool," they are in general not as essential to everyday IT operations as regular Internet access, e-mail, or distributed storage systems. In fact, the primary users of the technology in the 1998-2000 timeframe were Internet service providers and carriers offering dedicated Internet access. Enterprises have only begun to understand how to use the technology over the past 12-18 months, making the total market equal to the sum of the declining service provider revenues, offset by the slowly climbing enterprise revenues.

Figure 26: Layer 4-7 Addressable Market Forecast
($ in millions)



Source: Dell'Oro for historicals, and JPMorgan estimates.

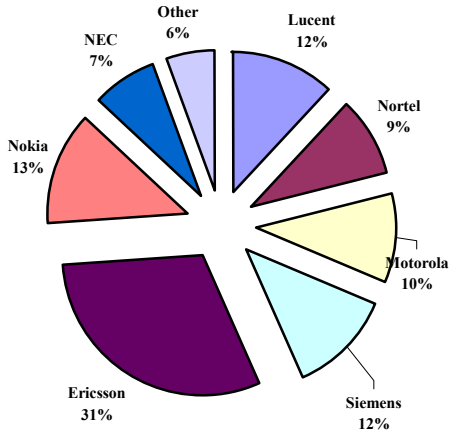
The entire Layer 4-7 market totaled $391 million in 2001, flat with 2000, and has since fallen 17% as of third quarter 2002 to a run rate of $350 million as most of the remaining ISP revenue bases dried up. Our estimate for full-year 2002 is $341 million, down 13%. We expect the market to continue shrinking throughout 2003 as enterprise CIOs allocate their spending on switching to more mundane requirements such as Layer 2 and 3 access, but as the economy begins to pick up speed in the beginning of 2004, we can envision enterprises stepping up their spending on the fancier services opened up by Layer 4-7 technology. Our 2003 and 2004 market growth estimates are for a 10% decline followed by 27% growth. We expect the first of these hot applications to be Intranet security, in response to new forms of attack made possible by more complex web traffic such as XML.

Wireless Infrastructure

Wireless infrastructure pertains to all equipment used by wireless carriers at the cell tower (called base station equipment, or BTS), at the base station controller (where traffic from multiple base stations is aggregated and backhauled to switches), and at the mobile switching center (which acts as a the bridge or gateway between the wireless world and the wireline world). Everything beyond the mobile switching center in a wireless network is functionally equivalent and in general identical to the wireline telephone network.

In our coverage universe, only Lucent and Nortel sell into the wireless infrastructure market, but the category makes up 49% and 40% of their total revenues, respectively, and together, they represent nearly 20% of the total market, with Ericsson, Nokia, Motorola, and Siemens making up the majority of the rest.

Figure 27: Wireless Infrastructure Market Shares for First Six Months of 2002
($ in millions)



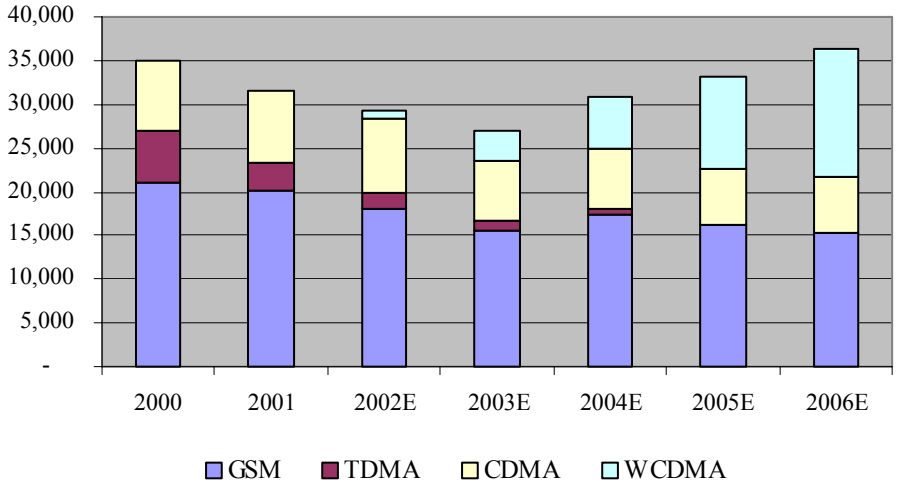
Source: The Dell'Oro Group.
Note: Does not include certain specific technologies such as FOMA, PHS, and PDC.

Of the companies in our coverage universe, Lucent is most leveraged to CDMA, while Nortel's exposure is roughly equally weighted between CDMA and GSM/GPRS/EDGE. CDMA (Code Division Multiple Access) is the Qualcomm-developed wireless technology used primarily by Sprint PCS and Verizon Wireless in North America, China Unicom in China, SKT, KTF, and LG in Korea, and a smattering of telcos in other southeastern Asian countries. Both Lucent and Nortel have also developed 3G Wideband CDMA (WCDMA) technology, although revenue from this equipment is still very small. Lucent, which recently completed a WCDMA test with Verizon in the Washington, D.C., area but has not yet deployed the technology commercially, has said it will not recognize any WCDMA revenue in its 2003 fiscal year, while Nortel is already recognizing modest 3G revenue from Vodofone.

WCDMA, also known as 3G or UMTS, is a new generation of wireless access system based loosely on the same technology as CDMA, providing data speeds up to 144 kbps, versus the 30-40 kbps in GSM/GPRS and the 70+ kbps in CDMA 1X-RTT. Currently, the only providers of WCDMA 3G services are NTT DoCoMo in Japan; Hutchison Wireless, which is entering the U.K. and Italian markets by year-end; and Mobilkom in Austria. J-Phone in Japan is planning to launch its 3G network before year-end 2002. The majority of European operators, including Vodafone, TIM, Deutsche Telekom's T-Mobile, Orange, and KPN, have government-mandated WCDMA buildout requirements that came as a condition with their spectrum licenses. However, the conditions are rather modest in terms of the depth of

coverage they require, and most companies have indicated that they will not aggressively build out or market 3G services for at least another year, although we believe this could slip into late 2004/early 2005. We estimate that these mandatory builds should drive a modest $3-4 billion of 3G revenue in 2003, up from approximately $800 million to $1 billion in 2002.

Figure 28: The Wireless Infrastructure Addressable Market
($ in millions)



Source: Dell'Oro for historicals, and JPMorgan estimates.
Note: Does not include certain specific technologies such as iDen, FOMA, and PDC.

The size of the total wireless infrastructure market was approximately $7.2 billion in the June quarter of 2002, down sharply from $9.2 billion in the year-ago quarter, according to Dell'Oro estimates. These market sizes exclude services revenue, which is approximately 20% of total wireless revenues, and the less mainstream standards iDen, FOMA, PHS, and PDC. The key driver of the falloff was cutbacks in GSM spending as the major European operators, including Vodafone, Telefonica Moviles, and MMO2, completed their GPRS overlay networks. Slightly offsetting the European effect were the large American GSM players AT&T Wireless and Cingular, which collectively grew capex 42% from 2000 to 2001 and should grow capex another 14% in 2002 as they continue to roll out their new GSM/GPRS and EDGE networks. We expect AT&T Wireless and Cingular capex to drop 25% in 2003 as they complete their GSM overlay networks.

We expect the total wireless infrastructure market in 2002 to hit $29 billion, down 7% from $31 billion in 2001. For 2003, we expect the market to decline another 8% to $27 billion, driven mainly by pushouts of WCDA 3G spending and the winding down of the North America overlay network deployments (GSM/GPRS at AT&T Wireless and Cingular, and CDMA 1XRTT at Verizon and Sprint PCS). From a geographic perspective, we expect a majority of the 8% decline in 2003 to come from North America, with spending in Europe and Asia remaining roughly flat.

WCDMA represents the next big driver of industry growth. However, judging by the lack of apparent urgency on the part of carriers to spend new capital at the present time, we are not modeling significant 3G revenues until late 2004, with the bulk of 3G network upgrades coming in 2005.

Our projection of an 8% decrease in overall wireless infrastructure revenue in 2003 is based on three factors. First, current 2.5G technologies, like CDMA 1X-RTT, GPRS, and EDGE, already represent sizable step-ups in user speed from the 2G technologies they are replacing, and it is not entirely clear yet which data-intensive killer applications, if any, will gain enough traction to force the need, from a pure capacity standpoint, for another upgrade so soon. Second, after plowing nearly $7 billion of capital into 2.5G networks in North America alone over the past two years, carriers, in our opinion, will likely look to first gain a positive return on that invested capital before rendering it obsolete it with new technology. Third, with most of the populated parts of North America and Europe covered with wireless access already, the bulk of the "coverage" part of the wireless network deployment in those areas of the world is near completion. This leaves new growth from coverage deployment to come from the emerging market economies.

Spending on CDMA technology over the four-quarter period from second quarter 2001 to second quarter 2002 remained relatively flat at $2 billion per quarter, which helped balance both LU's and NT's top lines as wireline spending fell off. The key drivers behind the stable CDMA revenues were Verizon's and Sprint's upgrade deployments in 2001 and 2002 to CDMA 1X-RTT, as well as China Unicom's phase one deployment of its new CDMA network. Note that China Unicom, the No. 2 wireless player in China behind China Mobile, also operates a 50 million subscriber GSM network.

Despite China Unicom's phase two expansion contract, in which Lucent and Nortel have already received contracts worth $430 million and $255 million, respectively, we expect the CDMA wireless infrastructure market to fall 18% in 2003 to $6.8 billion from our 2002 estimate of $8.3 billion, as the upside of another China Unicom build and the potential of a new CDMA deployment in India is offset by the completion of both the Verizon and Sprint 1X network upgrades in the United States. By 2004, we expect spending on CDMA infrastructure to trend up 10% as carriers begin upgrading to CDMA2000 (which is also called 1XEV and is a next-step variant of the current CDMA architecture) before hitting the full upgrade necessity of 3G.

Judging by discussions with carriers, we do not expect WCDMA builds to begin in earnest until 2004 at the earliest, with only approximately $3.0-4.0 billion in global WCDMA spending for all of 2003, up from our 2002 estimate of $800 million but still too small to make a significant difference in the global marketplace. The bulk of the WCDMA revenues should come from Hutchison Wireless, which is building the first 3G network in Europe, and several of the European carriers that have government imposed build-out requirements attached to their 3G licenses.

ATM Multi-Service Switching

Multi-protocol label switching (MPLS): a protocol that provides traffic engineering and quality-of-service characteristics to IP. MPLS enables multiple protocol types to run over an IP network.

Multi-service switches (MSS) are basically asynchronous transfer mode (ATM) switches that also support frame relay, IP, and MPLS—hence the term multi-service—and are the next generation of ATM switch. They can be used in place of a standard ATM switch in the wide area network (WAN) today, yet they also allow for a smooth migration to an all IP network down the road. MPLS, standing for multi-protocol label switching, is a protocol that adds traffic engineering capabilities and quality-of-service (QoS) characteristics to IP, which by itself is a very unreliable protocol (take, for example, the number of times web browsers hang and don't find the pages they are searching for). In this way, MSS harnesses the dependability and ubiquity benefits of ATM in an IP-based network and provides a bridge for carriers between their currently deployed ATM and frame relay networks and the more cost-effective IP-based architectures, toward which we believe most North American carriers will gradually migrate.

Channelized interface: a channelized interface breaks a data "pipe" into several smaller "pipes," enabling the support of a greater number of customers. For example, a T1 interface supports 100 end-user connections, whereas an unchannelized T1 interface supports only eight end users. Channelization is designated by a lower-cased "c" at the end of the port type.

While ATM did not catch on as quickly as vendors and carriers expected following its introduction in the late 1980s, it has been steadily deployed worldwide, remaining one of the faster growing, higher margin data services carriers offer today. Most high-time and latency-sensitive data today, such as financial trading data and plain old voice, is transmitted over an ATM backbone network. The growth of ATM services has largely been driven by corporate adoption of ATMs for firms' own WAN connectivity (e.g., connecting office buildings across multiple cities), owing to its reliability and high service quality. The need for ATM capacity accelerated in 1999-2000, driven in part by the RBOCs' aggressive deployment of DSL, which is based on ATM, and also by an upgrade cycle to denser line card configurations, facilitated by the availability of new technology such as channelized interfaces.

We expect service providers to begin adopting packet-based Class 4/5 switch alternatives in place of their current circuit-switched voice switches, providing a new driver of MSS market growth beginning in approximately 2005. It is our understanding that several incumbent U.S. carriers—including Verizon, Qwest, AT&T, and Sprint—have current outstanding RFPs for new multi-service switch purchases. We expect these carriers to make decisions over the next six to 12 months, although actual purchasing may be delayed until 2004. Verizon has also begun to use Nortel's ATM switches for tandem switching (voice traffic) applications, which feed into the larger Nortel Passport 15000 core ATM switches. Over time, we expect carriers to continue driving down the cost of ATM service offering by migrating their ATM core networks to the lower operating expense costs of an IP/MPLS backbone.

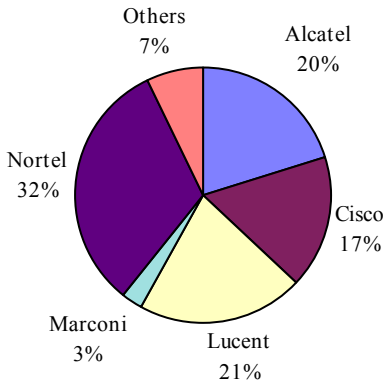
While ATM has proven to be a valuable technology, it has not converged disparate voice, video, and data networks, as engineers originally thought it would. However, as carriers work to cut their operational costs in response to weak top lines, many are looking to consolidate their varied and disparate networks into a single network, running one IP/MPLS network in support of voice, ATM, frame relay, IP and other forms of data. The MPLS option is needed to supplement pure IP for the time-sensitive ATM, frame relay, and voice services because IP lacks the low latency and high quality of service those services require.

What Is MPLS?

MPLS is a data networking protocol being developed by the Internet Engineering Task Force (IETF). IETF development of the MPLS control plane began in early 1997 as a means to provide IP traffic with a quality of service mechanism and help scale the Internet by introducing circuit-switching techniques to packet-switched, connectionless networks. MPLS is a Layer 2-3 protocol (though it does not replace Layer 3 addressing or IP functionality) that creates a software-based label-switching control plane similar to ATM.

As the name multi-protocol implies, MPLS is not specific to IP and can be used with other protocols such as ATM, frame relay, or Ethernet. MPLS uses a series of labels that dictate the forwarding path of data in packet networks. The labels are used instead of IP addresses to route traffic. This label-swapping technique eliminates the requirement for each router and switch in the traffic path to process data other than the label, effectively streamlining packet processing.

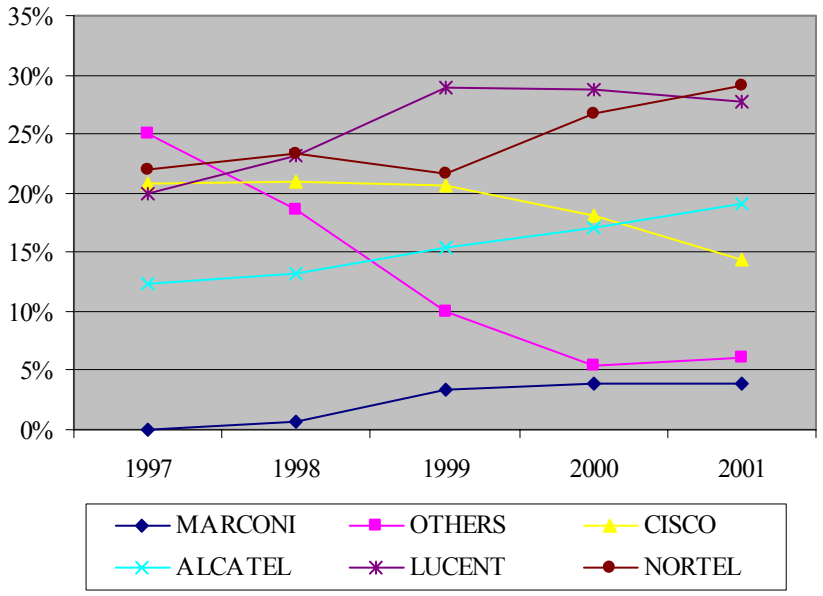
Figure 29: The Multiservice Switch Market Is Dominated by Four Players
(as of 3Q02,% dollar share)



Source: The Dell'Oro Group.

The Market—Dominated by Four Players
The market for ATM switches has historically been dominated by four vendors—Nortel, Lucent, Alcatel, and Cisco (see Figure 29). Interestingly, every vendor aside from Nortel entered the market through a significant acquisition (Lucent acquired Ascend Communications, which had previously acquired Cascade Communications; Alcatel acquired Newbridge Networks; and Cisco acquired Stratacom). The distant No. 5 player Marconi also entered the market through the acquisition of FORE. In the third quarter of 2002, Nortel held the top spot with 31.9% market share, up 290 basis points from full year 2001. Nortel has steadily been gaining share with its Passport 15000 and new Passport 20000 ATM switches at Lucent and Cisco's expense (see Figure 30). Lucent lost its top spot to Nortel in the third quarter of 2001 and has lost 710 basis points of share since, registering 21.1% share as of the second quarter of 2002. Lucent has not invested until just recently in its ATM switch families.

Figure 30: Nortel Has Slowly Risen to the Top Dollar Share Spot



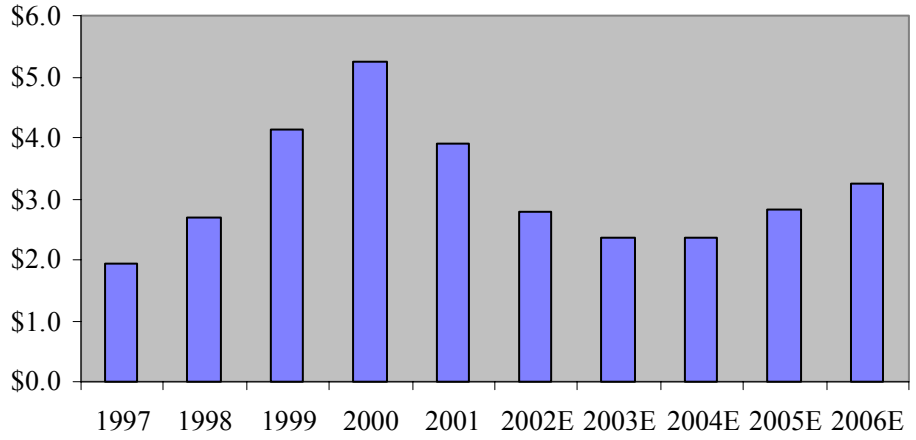
Source: The Dell'Oro Group.

Lucent, which recently launched and then subsequently canceled the TMX 880, a multi-service switch built off the Nexabit routing platform acquired in 1999, has been losing share in the ATM market and has yet to gain traction in the latest generation of the technology. Cisco has also been losing share but recently stemmed losses through the launch of the 180 Gbps MGX 8950, which is aimed squarely at the Nortel Passport 20000, Nortel's high-end 160 Gbps switch. Cisco's share of 16.8% as of third quarter 2002 represents a 130 basis point decline from Cisco's share position in 2000 but a 250 basis point increase from the company's share position in 2001. Alcatel has also benefited from Cisco's share losses, growing its share to 20.2% in the third quarter of 2002, up 110 basis points over Alcatel's 2001 level. Alcatel recently launched the 7670 RSP and has been gaining share with this product.

Expecting a Recovery in 2005

We expect revenue for multi-service switches to decline 15% in 2003 to $2.4 billion, a less steep decline than the 29% drop we estimate for 2002 and the 25% decline in 2001. We expect revenue to flatten out in 2004 as capital budget cuts among carriers slow and corporate IT spending begins to pick up, followed by 20% growth in 2005 to $2.8 billion (see Figure 31) and 15% growth in 2006. We expect the spending resurgence in 2005 to be driven by carrier transitions to packet-based voice networks, the availability of denser MSS switches that support traffic growth, and pent-up capacity restraints on existing switches as a result of the low capital expenditure budgets in 2003 and 2004. Spending on multi-service switches peaked in 2000 at $5.2 billion, reflecting the strong spending environment from 1998 to 2000.

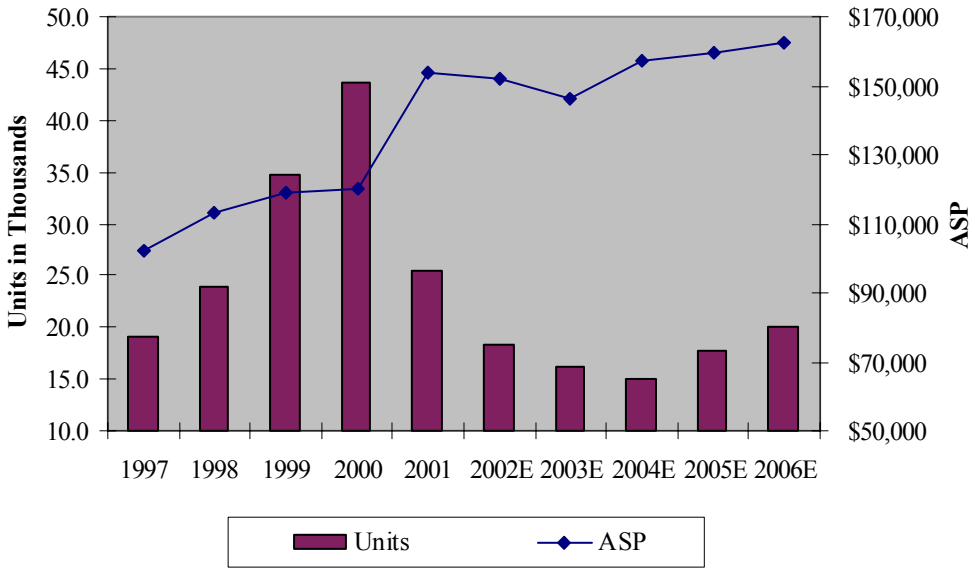
Figure 31: Multi-Service Switch Addressable Market
($ in millions)



Source: The Dell'Oro Group and JPMorgan estimates.

Our revenue outlook through 2006 comprises upward-trending ASP and somewhat volatile port growth—2.4% and 1.6% CAGR, respectively—over the next four years (2002 to 2006). In contrast to most prices for telecom equipment, ASPs for ATM switches have grown over the past five years, rising from $102,000 per port in 1997 to an estimated $152,000 per port in 2002, an 8.3% CAGR. The growth in ASPs is a bit misleading, however, in that what is considered a port today is different in the past. For example, today's ports support optical interfaces (i.e., optical interfaces such as OC-12 and OC-48, versus electrical interfaces such as DS-3) or are channelized (i.e., OC-3c versus OC-3) and are laden with far more features (such as the multi-service capability rather than just ATM) than what counted as a port only five years ago. As a result, the ports compared in Figure 32 do not provide a true apples-to-apples comparison.

Figure 32: ASP Should Trend Upward While Port Counts Grow Off 2004 Low



Source: The Dell'Oro Group and JPMorgan estimates.

Multi-service switches come in two varieties: edge and core. An edge switch generally aggregates data from multiple users at the access points of a network and ships them off into the middle, or core, of the network, for processing by the much larger and faster core switches. Similar to other network elements, the edge varieties typically operate at lower capacities, with interfaces of OC-3 and below and total switching capabilities of up to 25Gbps, yet they are more services-intense, as they cater to the end users' particular network architecture needs. Core switches, on the other hand, focus on much higher capacity interfaces (OC-3 and above) and raw throughput, with switching capability north of 50 Gbps.

We continue to expect optical interfaces to grow faster than electrical interfaces and for channelized line cards to grow at a faster pace than unchannelized line cards. If history were to repeat itself—which we expect to happen—carriers will move their existing core switches to the edge and install the latest technology in the core of the network when the need for new capacity presents itself. The continued adoption of ATM and frame relay services should dictate demand for edge switches, as customer growth directly influences the amount of aggregation capability needed. We also expect lower density, unchannelized line cards to be replaced with more efficient channelized varieties.

IP Routing

At the most basic level, IP routers simply send and receive packets of data from one part of the Internet to the other. While they use a variety of rules, or protocols, that assist them in figuring out which way to send each packet—rules that often have fancy names and acronyms, such as Border Gateway Protocol (BGP), Resource Reservation Setup Protocol (RSVP), and Multi-Protocol Label Switching (MPLS)—for the most part, most routers do essentially the same thing. They sit at the junction points of the network in both wide area networks (WANs) and metropolitan area networks (MANs) and intelligently route packets based on a packet's IP address and an internal, constantly updated table called a routing table.

A special feature of routers is that they continually monitor whether the packets they pass on actually get to where they are going in order to learn whether that particular routing was a good one and then use that information to update their routing table for the next packet. Most early routing tables were implemented in software before Juniper introduced its first ASIC-based implementation (ASIC stands for Application Specific Integrated Circuit and is a chip-based version of a software program) that turbo-charged routing speeds and forced Cisco and others to follow Juniper's lead.

Ignoring the varieties of protocols and service features for the moment, the primary distinction between different routers is speed. Juniper's primary M-series family of routers, for example, consists of the M5, M10, M20, M40, and M160, where the number following the M refers to the routing speed in gigabits/second (Gbps). Juniper also sells a T320 and a T640, which have peak speeds of 320 Gbps and 640 Gbps, respectively, but use a different architecture that allows them to scale more efficiently then the M-series routers can. Aside from this scalability feature, they serve essentially the same function as the M-series routers in essentially the same way, just faster.

Despite the multiple gradations in speed, most engineers think about routers in terms of two sizes: core, which are the high-end, high-speed routers that are fast enough to run in the heart of the WAN networks; and edge, which are smaller and sit in the MAN or LAN. Of course, depending on the size of the network itself, one company's core router is another company's edge router, although in general, 40-80 Gbps and above is consider core, while 10-20 Gbps and below is considered edge. Owing to where edge routers sit in a network—closer to the end-user—they are generally also designed with more service features, such as virtual routing.

The WAN, or core of the network, is the main backbone over which all data travels. The MANs sit on the periphery of the wide area network and offload all the data traveling in the core onto corporate networks (LANs) and residential users. Inside the router, a constantly updated table of IP addresses is referred to whenever a packet of data needs to be routed to a given address. The router will then determine the best path for the packets to take to reach the destination in the shortest amount of time and with the smallest number of problems.

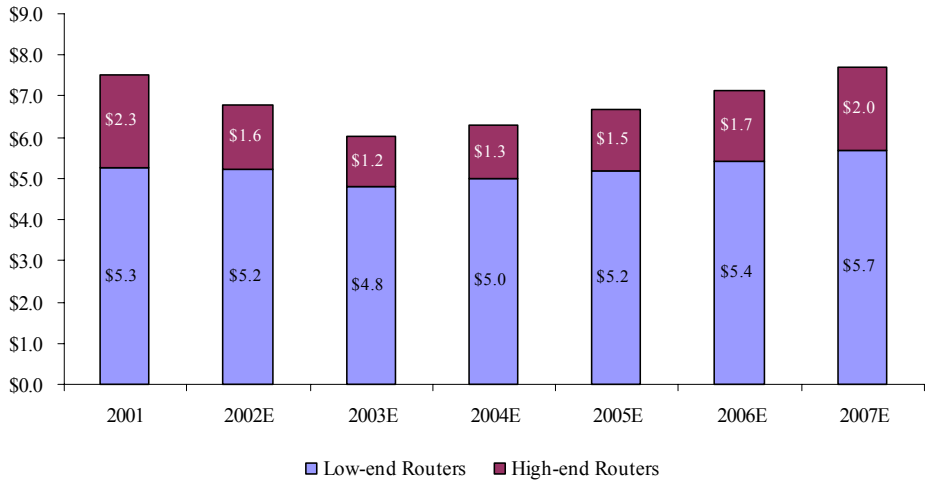
Smaller routers are used to aggregate data traffic from the metropolitan area onto the wide area network. As network usage and bandwidth requirements grow, routers at the edge of the WAN become strained and need to be replaced by more powerful equipment. At the same time, the way network topologies have been evolving, more "intelligence" is being moved into the edge equipment (as opposed to the core equipment, where most intelligence traditionally lies in standard telephone networks) enabling new services such as security/ firewall and multiple service level guarantees (SLAs). Together, these two forces drive what should be a somewhat regular edge router replacement cycle, although, owing to the newness of IP networks in general and the fact that no one has been through an actual edge router replacement cycle before, the exact period of the cycle is unclear. Most estimates put it at three to four years, a timeframe we find reasonable, given similar cycle lengths for other pieces of data networking equipment.

The Market

We estimate the size of the IP router market in 2002 at approximately $6.8 billion, down 10% year over year. For 2003, we expect the market to decline another 12% to $6.0 billion before recovering in the second half of 2004 to $6.3 billion, up 5% year over year. Because the vast majority of routers are sold to carriers—including WorldCom's UUNet division and the long-distance side of Qwest, both of which are aggressively reducing spending—we expect the overall IP router market recovery to be consistent with our late 2004/early 2005 rebound estimate for carrier spending in general.

Figure 33: IP Router Industry Revenue

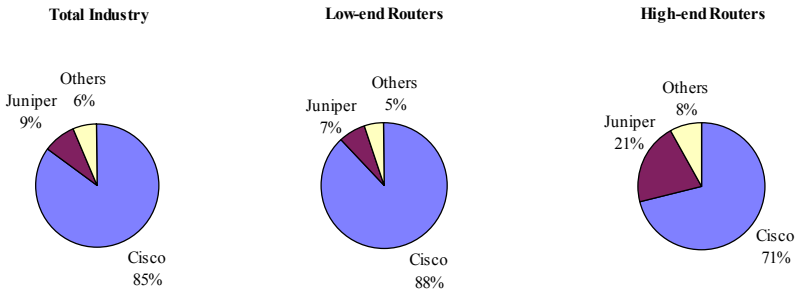
($ in billions)



Source: Dell'Oro for historicals, and JPMorgan estimates.

The overall router market is dominated by Cisco, which currently has approximately 85% of the total market share, representing approximately 27% of Cisco's total sales in the most recent fiscal quarter (first quarter 2003). Juniper is the No. 2 player, with a 9% share of the IP router market, representing over 95% of total sales in the company's most recent third quarter.

Figure 34: IP Router Industry Market Shares as of 2Q02



Source: Dell'Oro.

The low- to mid end range of the router market generally used for edge devices is dominated by Cisco's 88% share, representing approximately 22% of Cisco's total revenues. With its recent acquisition of Unisphere, Juniper is still a distant No. 2 player in this market with a 7% share, which we estimate made up approximately 45% of the company's total sales in the most recent third quarter.

Competition in the significantly smaller higher end core market, however, is divided between Cisco and Juniper, with Cisco still dominating the market at a 71% share (5% of Cisco's total sales), but with Juniper holding a respectable 21% share (approximately 55% of Juniper's total revenues). Note that our definition of high-end versus low-end is somewhat arbitrary and certainly open to debate.

The market for high-end routers was $2.3 billion in 2001 versus $4.9 billion for the lower end models; however, it has felt a greater impact from the economic turndown than the low-end market, falling, we estimate, 31% in 2002 to $1.6 billion versus a dropoff of only 3% for the low-end market. In general, we expect the edge router market to be relatively more resilient than the core market for the next 12-18 months, driven by the new service features that next-generation edge routers allow carriers to offer. This is in contrast to core routers, which are upgraded primarily for speed purposes. As carriers begin spending again on core network infrastructure in late 2004/2005, we expect high-end core routers to once again lead revenue growth and expand margins.

Pricing in both of these markets has remained fairly stable over the past several years, as competition has not been a major issue to date. Owing to the importance and sophistication of IP routers, we also believe that price is not a primary consideration when CIOs make purchasing decisions, as reliability and service are much more important metrics. Similarly, routers have increased in density and intelligence over the course of the past few years while the price of these products has remained fairly stable, giving customers better functionality value for their purchase price. We would expect pricing to remain fairly resilient going forward.

Optical Networking—Transport and Switching

What It Is

Optical transport and switching represents the physical layer equipment that literally transmits and receives the bits over today's optical networks. Beginning with Sprint's first all-optical fiber network in the late 1980s, nearly all networks today—voice, data, and cable—operate over optical fiber. The optical transport boxes are also called SONET boxes, after the protocol they use, and some of the most popular products in the category have been the Lucent FT-2000 and Nortel S/DMS, which are used extensively throughout the RBOC and other U.S. incumbent networks, and the Cisco 15454 (also known as the Cerent 454, after the company Cisco bought in 2000), which was popular among CLECs and emerging carriers in the 1998-2001 timeframe. The SONET standard specifies multiple transmission speeds, of which the most prevalent are OC-3 (155 Mbps), OC-12 (620 Mbps), OC-48 (2.5 Gbps), and OC-192 (10 Gbps).

Using a system that allows multiple SONET connections to simultaneously exist over the same fiber, engineers in the mid 1990s created the concept of dense wave division multiplexing (DWDM), whereby each of several colors of light transmits an independent SONET connection. Ciena was one of the early providers of DWDM equipment with its Multiwave 1600 product that it sold in quantity to Sprint and WorldCom, while other popular DWDM boxes were the Nortel OPTera 1600 and the Lucent Wavestar.

The final pieces of the optical network puzzle are the optical multiplexers and switches that act as the traffic cops at the access points and "joints" in the network, routing (in the generic car and truck traffic sense of the word) the incoming SONET signals from one part of the network to another. These switches come in three primary flavors: add/drop muliplexers (or ADMs), which are the oldest and most widespread workhorses of optical networks (these are the traditional SONET boxes, such as the Lucent FT-2000 mentioned above); core switches, which are large, very dense, super-high capacity switches with very high speed inputs; and metro switches, which are basically smaller versions of the core switches.

The metro-sized boxes generally require less power and physical real estate than their core brethren and are therefore cheaper to operate in smaller rings or rural central offices, where the slower traffic flow doesn't dictate a full-blown switch. What we call metro switches are sometimes also referred to as next-gen SONET boxes. Examples of some products in each of these three categories are the Nortel S/DMS and Lucent FT-2000 in the traditional ADM category; the Ciena CoreDirector, Nortel HDX, and Lucent LambdaUnite in the core switch category; and the Cisco ONS 15454, Lucent DMX, Nortel OPTera Metro 3500, and the Ciena MetroDirector K2 in the metro category.

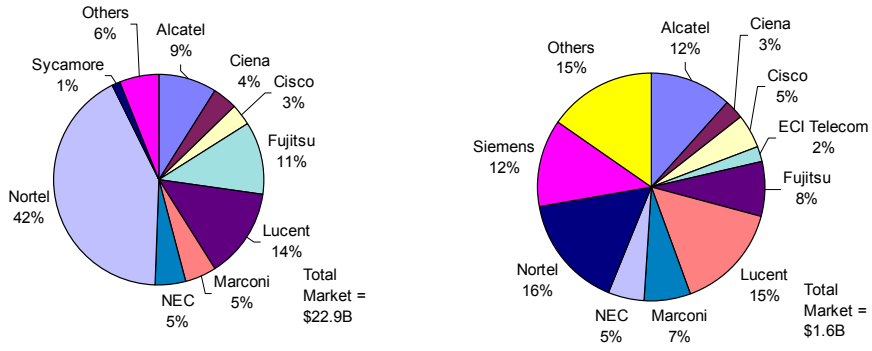
The Market

More so than any other product category in our classification, optical networking was a victim of its own success during the bubble, when $65 billion of equipment was deployed in 1998-2001 alone, according to Dell'Oro—more than two and one-half times the amount purchased in the seven years prior to 1998. The capacity-multiplying effect of DWDM (the development of which, in the mid 1990s, was a major driver of the spending boom), coupled with the misguided but often misquoted theory that demand for bandwidth would absorb any available excess supply, led to a significant surplus of long-haul capacity that carriers are still burning through today.

The market for optical gear peaked in 2000 at $23 billion, when revenues grew 50% year over year for the second straight year. Just 21 months later, in third quarter 2002, however, the total optical market had fallen 72% from its 2000 peak to a run rate of only $6.5 billion, led by the large incumbents Nortel (16% share), Lucent (15% share), Siemens (12% share), and Alcatel (12% share). During the peak year, 2000, Nortel dominated the market with a 42% share, primarily on the twin strengths of its OC-192 long-haul DWDM products and its

traditional ADM SONET products. Nortel's market leading shares in each of those categories in 2000 were 51% and 39%, respectively. The company's huge and successful gamble to leapfrog the OC-48 DWDM market that it was late in entering and instead focus R&D on an OC-192 product led both to its dominance and its heavy exposure when the market evaporated 18 months later.

Figure 35: Optical Networking Market Share, 2000 and 3Q02



Source: The Dell'Oro Group.

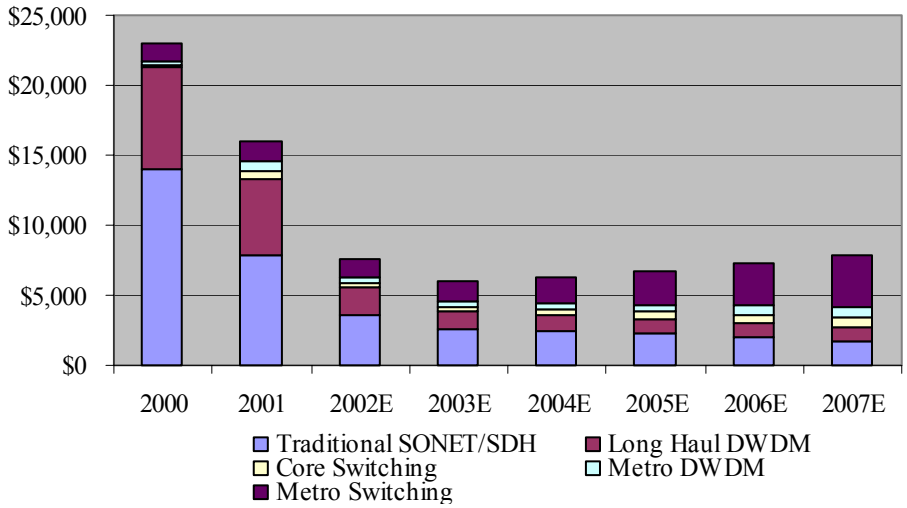
Directly behind Nortel in 2000 in the long-haul DWDM category was Lucent with a 16% share, and Ciena with an 11% share (which made up 82% of Ciena's entire business). Nortel's primary competitors in traditional SONET in 2000 were the large integrated vendors Fujitsu (17.1% share), Lucent (14.6% share), and Alcatel (9.7% share).

Owing to the collapse of the emerging long-haul carriers, sales of long-haul DWDM, which accounted for over 95% of the DWDM market and 32% of the total optical market in 2000, fell over 75% from $7.3 billion in 2000 to a run-rate of $1.8 billion in third quarter 2002. We believe that the long-haul DWDM market should continue to decline through the end of 2004 and into early 2005 as carriers continue to tighten budgets and eat through the excess long-haul transport capacity already deployed.

Any realistic near-term market growth over the next three years, therefore, should come primarily from the metro switch and metro DWDM segments as carriers build new metro fiber rings and incumbent service providers slowly replace the traditional SONET ADM gear that currently power their networks. Specifically, we expect the RBOCs to be the biggest drivers of optical spending growth in North America over the next three years as they upgrade their interoffice trunk lines and build fiber access out to the new enterprise customers they will try to attract following their 271 LD approvals in each state.

Figure 36: Optical Market Revenue, 2000-2007E

($ in millions)



Source: Dell'Oro and JPMorgan estimates.

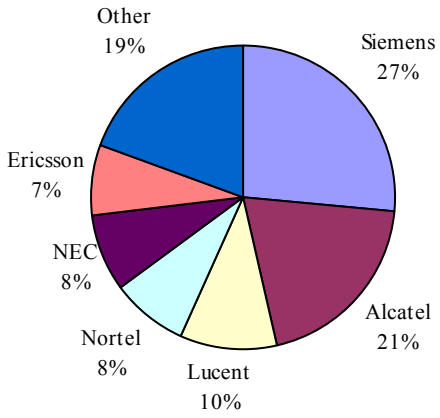
In 2003, we anticipate spending on optical networking equipment to decline 21% to $6.0 billion, a vast improvement over the 50% falloff in 2002 and the 30% falloff in 2001, owing to the slowing declines in longhaul DWDM (a decline of 34% in 2003 versus a 63% decline in 2002) and traditional SONET (a 29% decline in 2003 versus a 55% decline in 2002). In 2004, we estimate a slight rebound in optical networking spending, projecting growth of 5% to $6.3 billion, as new metro fiber builds in both North America and Europe should offset the continuing declines we expect in long-haul DWDM and traditional SONET.

Traditional Time Division (TDM) Voice

Traditional TDM voice equipment—such as Class 4 and 5 switches from Lucent (4ESS and 5ESS) and Nortel (DMS) and the voice circuit-specific transport equipment, such as digital cross connects (DACS) from Tellabs, Lucent, and Nortel—are the building blocks of today's current voice networks and have been used in nearly every ILEC and IXC network worldwide for over 20 years. Including the predecessor circuit switch equipment, such as the analog switches used in the voice networks before today's digital versions, TDM voice technology is over 50 years old.

The primary suppliers of this type of equipment are the large, traditional, incumbent integrated equipment suppliers such as LU, NT, Alcatel, Siemens, Ericsson, and Fujitsu. In the past, each of these companies also had a somewhat captive customer base in that it was the primary company to supply the major, often government-controlled, in-country service provider. For instance, Lucent supplied AT&T and the seven U.S. regional Bell Operating companies, Nortel supplied Bell Canada, Alcatel supplied France Telecom, Siemens supplied Deutsche Telekom, etc. In fact, many of these equipment providers were originally part of the service provider itself.

Figure 37: Global Market Share of TDM Circuit Switch Voice Market--2001



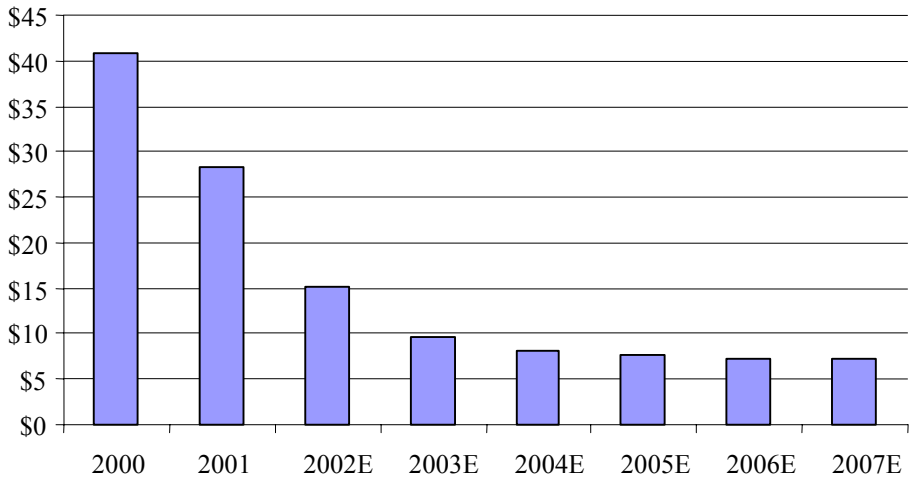
Source: Synergy and JPMorgan estimates.

In the United States, spending on TDM voice switching began to take off in the late 1990s following the passage of the 1996 Telecom Act, as hoards of upstart telecom companies—called CLECs in the local market and emerging IXCs in the long-distance market—raced to build duplicate networks and compete for a share of the $100 billion-plus U.S. wireline telecom market. Because voice traffic was both plentiful and already generating revenue, many of the new network provider business models called for entering the existing voice market with traditional TDM voice equipment while preparing their next-generation networks for the what they all generally agreed was a coming onslaught of IP and packet data-intensive applications.

Some of the CLECs, on the other hand, only had intentions of cracking open up the *de facto* monopolies that the ILECs had on the local voice business. In either case, the rapidly growing set of new carriers in both the United States and Europe radically expanded the total addressable market for TDM carrier voice equipment to a peak of $41 billion in 2000. Also contributing to the sudden uptick in spending near the end of the decade was the rapid increase in dial-up Internet surfers. Because the typical dial-up Internet call lasts well over half an hour, compared with the average voice call time of five to seven minutes, dial Internet users began to create a shortage in local voice ports on the Class 5 TDMA switches, forcing the local carriers to increase capacity.

Today, the market for TDM voice equipment is contracting quickly as incumbent carriers in both North America and Europe continue to cut back capital programs (see page 9 for our maintenance spending analysis), and the new entrants are mostly either in Chapter 11 or operating under drastically reduced business plans. The current spending run rate by carriers on TDM voice equipment should decline to just $15 billion in 2002 from $41 billion in 2000, and we expect the market to continue to decline at a 20% CAGR over the next three years.

Figure 38: TDM Circuit Switched Voice Market Forecast
($ in billions)



Source: Synergy and JPMorgan estimates.
Note: 2002-2007 are estimates.

While we do not believe that circuit-switched voice is a dead technology, we do believe that over the next five to seven years, growth in voice capacity will increasingly be handled by packet-switched technologies in a cap-and-grow strategy. Continued spending by carriers on TDM voice equipment therefore will only represent standard maintenance on their existing switches and networks, while the growth should occur in the softswitch-based switching technologies.